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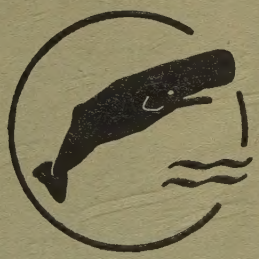

THE WHALES RESEARCH INSTITUTE
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Attempt to Preserve Freshness of Whale Meat With Germicides. II.

By
Shichiro Akiya, Otomatsu Hoshino
and
Nobuo Motohashi

(Received January 1954)

In recent years, ground for coastal whaling have been getting further and further away from the land and, consequently, the time elapsed between catching and dissection has become larger. This in turn has posed the question of the lowering of the freshness of whale meat.

Some experiments have previously been made for the preservation of freshness of whale meat but they seemed to have been rather ineffective.

Attempts have recently been made to charge the harpoon with a germicide so as to allow the drug to penetrate into whale meat on harpooning and thereby prevent decaying of meat. In three occasions during 1950 and 1951, Guanofuracin (5-nitrofurfurylidene-aminoguanidine hydrochloride), was used as such a germicide.

The results were described in the first paper of this series[1], which showed some effect in successful examples but due to the small number of examples obtained, the same experiments had to be carried out further. Fourth occasion was the experiments carried out during July and August, 1953, during which harpoon charged with Guanofuracin was used with fairly effective results, which are described herein.

Experimental

I. *Methods*

Methods used were based on previous experiments with numerous modifications and revisions which will chiefly be described.

1) Improvement on the Harpoon: Ordinary harpoon had been used in the previous experiments, but it was modified with a screwed cover so as to facilitate insertion of Guanofuracin can from the head, and a partition was placed between the can and an explosive. This improved harpoon, shown in Fig. 1, is slightly larger than the ordinary harpoons used.

2) Amount of Guanofuracin used and its Container: Ordinary can-

ning cans of about 300cc. capacity were used as the containter for Guanofuracin*. At first, fairly good results were obtained by the use of a 20 gm. can. Later, 40 gm. cans were prepared but owing to unfavorable weather conditions and moving of catcher boats, sufficient use of the larger cans could not be made.

3) pH-Measurement of Whale Meat: pH of the meat was measured with Guanofuracin-injected whales and control whales. Dorsal meat was taken up at first but later, ventral and tale meat were also measured for comparison.

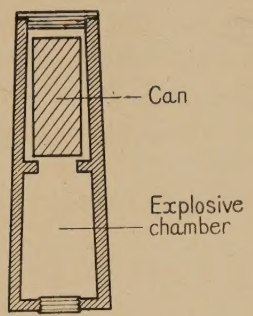

Fig. 1

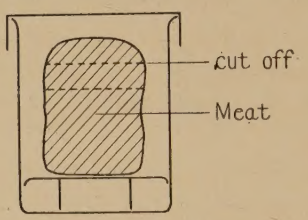

Fig. 2

Fig. 1. Improved Harpoon for Guanofuracin
Fig. 2. Meat Beaker

The meat was handled as aseptic as possible, cut into portions of 100-200 gm. size, and placed in a beaker with raised bottom (Fig. 2). The beaker was covered with a petrie dish so as not to make the beaker air-tight, and placed in a thermostat of 30° temperature. The meat was cut from the top at intervals of several hours or over ten hours, and variation in pH values of the meat was measured.

pH measurement was carried out with the glass electrode pH-Meter and pH test paper, as in the previous experiments, but the glass electrode used was the one for muscle measurement.

4) Measurement of Guanofuracin Concentration in Blood: The measurement was carried out as in the previous experiments. Guanofuracin was added in various proportion to the blood of control whale, acidified with acetic acid, heated, and filtered. The filtrate was made

* The cans used were treated with paint on the innerside and presented no problem but during the course of these experiments, there was shortage of cans and change in the content of Guanofuracin. Galvanized iron was used for the cans in which aqueous solution of Guanofuracin was placed but Guanofuracin was found to undergo change by reacting with zinc and iron in the can material. It is therefore advisable to avoid using cans in which the metal is exposed on the inside.

alkaline and this was used as the standard for colorimetric determination[2].

II. *Results*

1) In the earlier part of experiments, about dozen sperm whales were obtained and the period was extended to include a few examples of sei whales. One each of fin whale was obtained for Guanofuracin injected and control cases.

2) Table 1 gives the species and sex of whales in which Guanofuracin harpoon was used, time elapsed until dissection, pH value of meat, and presumptive blood level of Guanofuracin. The term "putrefaction inhibition rate" used in Table 1 was calculated by taking pH of the control whale meat as 0% inhibition rate and pH of toluene-added meat as 100%. The summarized judgement was arrived at by examining the state of harpooning, location of harpooning, observations at the time of dissection, presumptive blood level of Guanofuracin, external apparent change of meat, and pH curve, the order given being A, A', B, C, and D.

3) Table 2 gives the kind and sex of whales and pH value of meat in control whales and in whales caught just prior to experiments and on which Guanofuracin harpoon was not used.

4) Figs. 3–8 give summarized results of representative pH curves obtained on experimental whale meat. They give pH curve of meat in whales in which Guanofuracin was comparatively well circulated and that of control. In these figures, the time of catching, and therefore of death, was taken as zero, and the shaded portion shows the time spent in landing and dissection, and the rest is the time during which the sample meat was kept in a theromostat at 30° and pH of the meat measured at certain intervals. pH values of tail and ventral meat are also gived for comparison.

III. *Discussions*

1) Freshness and pH of Meat at the Time of Dissection: From the determination of pH of Whale meat under various conditions, it has been observed that there is a close relationship between freshness and pH of the meat at the time of dissection. During 30–40 hours after catching, when the meat is fresh, pH value is quite high and pH value is low when the freshness is impared (cf. Table 1). Owing to the extremely small number of experimental animals, however, this point needs further investigation.

2) pH value of Dorsal, Ventral, and Tail Meat: pH value of tail and ventral meat seems to be generally higher than that of dorsal meat

Table

No.	Species	Sex	Body length (ft.)	Date of captured	Duration (hrs.) a)	Freshness (%) b)	No. of G.F.-harpoon used	No. of G.F.-harpoon hit c)
2	Sperm	Female	37	July 20	26.00	70	1	1
3	〃	〃	35	20	25.30	80	2	1
4	〃	〃	39	22	25.00	60	1	1 (missed)
6	〃	〃	36	22	25.00	70	1	1
8	〃	〃	38	24	29.00	70	1	1
9	〃	〃	35	24	28.15	70	1	1
10	〃	〃	37	24	28.15	70	1	1 (can unexploded)
11	〃	〃	35	24	27.30	70	1	1
12	〃	Male	48	26	31.20	65	1	1
13	〃	〃	36	26	32.00	70	1	1
14	〃	Female	35	26	32.00	75	1	1
15	〃	〃	36	26	32.00	60	1	1
17	Sei	〃	46	27	25.00	60	1	1
18	〃	Male	44	Aug. 4	14.00	65	1	1 (40 gm.)
19	〃	〃	42	6	6.10	85	2	1 (missed) 1 (hit)
20	Sperm	Female	36	9	20.40	75	1	1 (can unexploded)
21	Fin	Male	60	12	26.00	60	1	1
22	Sei	Female	41	16	27.00	70	1	1 (40 gm.)

G.F.=Guanofuracin (5-Nitrofurfurylideneaminoguanidine hydrochloride)

a) Duration of time between catching until dissection.

b) Freshness gives the degree of freshness at the time of dissection as designated

c) Unless otherwise noted as 40 gm., the 20 gm. can of guanofuracin was used.

at the time of dissection but the rate of putrefaction is the most rapid in tail meat. pH values of dorsal and ventral meat are varied under different conditions (cf. Figs. 6–8).

3) Relationship between Freshness and Guanofuracined Whale Meat: It has been observed that the freshness of whale meat depends on the location of harpooning, time elapsed between harpooning and death, duration towing, atmospheric and sea-water temperature, and nutritional condition of the whale. Since the autolysis of the meat and rate of putrefaction are dependent on the foregoing factors, the freshness of the meat is not necessarily maintained until the time of dissection by Guanofuracin injection. As long as a fairly reasonable amount of the drug is in circtlation, the freshness is naturally maintained (cf. Table 1).

4) Location of Guanofuracined Harpooning and State of Guanofuracin Circulation: In general, the freshness of meat is maintained

1.

pH of dorsal meat		Presumed Blood Level of G.F. (mg. %)	Putretaction inhibition rate (%)	Elapsed Time until death (min.)	Summarized judgement
At dissection	40 hrs. later (30°C)				
5.85	7.10	0.1~0.2	10	0~1	D
5.90	6.70	0.4~0.5	40	4	A′
5.80	7.25	0 (control)	0	3	—
5.75	6.85	0.2~0.3	25	0~1	C
5.80	6.50	0.3~0.5	50	3	A′
5.65	6.40	0.6~0.7	60	1	A
5.60	7.40	0 (control)	0	8	—
5.70	6.60	0.3~0.4	40	2	A′
5.55	6.85	0.4~0.5	35	16	B
5.60	6.65	0.7~0.9	55	5	A
5.70	6.95	0.3~0.4	30	0~1	B
5.50	7.00	0.2~0.3	20	2	C
5.70	6.85	0.2~0.4	25	—	C
5.75	6.70	0.3~0.5	35	—	B
5.90	6.75	0.3~0.4	30	15	B
5.80	7.00	0 (control)	0	3	—
5.80	6.95	0.3~0.5	25	—	C
5.80	6.65	1.0~1.2	50	—	A

by fishery workers by experience and does not give a chemically determined data.

when ordinary harpoon strikes the head or chest portion, and freshness is extremely lowered when the harpoon strikes the ventral side. With harpoons charged with Guanofuracin, the best result was obtained when it struck the chest portion.

5) Relationship between Guanofuracined Whale Meat and Rate of Putrefaction: As long as certain amount of Guanofuracin is circulating through the body, the rate of putrefaction is suppressed in accordance with the amount as compared with the control whale (cf. Figs. 3-8). In some outstanding examples, no putrefying odor was detected even after a few days at 30°. This fact was also observed in few successful cases described in the previous report and was confirmed in the present series of experiments by larger number of successful cases. (especially Nos. 3, 8, 9, 11, 13, and 22) in which Guanofuracin was effective in preventing putrefaction.

Table 2

No.	Species	Sex	Body length (ft.)	Date of captured	Duration (hrs)	Freshness (%)	pH of dorsal meat		Weather	Water temparature (°C)
							At dissection	40 hrs later (30°C)		
1	Sei	Male	41	July 13	32.35	50			B	13.0
2	Fin	〃	51	15	15.50	75			F	13.0
3	Sei	〃	40	16	9.00	80	5.80	7.10	B	14.0
4	Sperm	〃	35	23	29.10	60			O	18.5
5	〃	〃	36	23	28.35	65			〃	〃
6	〃	〃	36	23	28.27	60			〃	〃
7	〃	〃	44	Aug. 2	14.40	60			RF	21.0
8	〃	〃	46	2	14.25	60			〃	〃
9	Sei	〃	37	5	12.55	70	5.70	7.05	C	15.5
10	〃	Female	45	11	26.25	65			BC	26.0
11	〃	〃	48	12	27.05	60			C	20.5
12	Sperm	Male	54	14	10.50	80			CF	16.0
13	Sei	〃	43	15	21.30	70	5.85	7.30	FC	20.5
14	Fin	〃	54	15	24.55	70	5.80	7.40	FC	21.5
15	Sei	Female	43	16	28.25	70	5.80	7.20	B	20.0
16	〃	〃	44	16	29.40	65	5.70	7.30	B	〃
17	〃	Male	37	16	30.45	60			B	〃
18	Sperm	Female	36	18	25.00	70	5.70		BC	〃
19	〃	〃	35	18	26.45	60			C	〃
20*	〃	Male	36	18	34.29	60	5.80	6.80	B	〃

* No. 20 is injected with 60 gm. Boakinin.

(Addeddum)

At a later stages of the present series of experiments, comparison of antiseptic effect of Guanofuracin and that of butyl p-hydroxybenzoate, one of the antiseptics used for foodstuff, against whale meat showed no great difference and, therefore, cans containing 60 gm. of Boakinin B (butyl p-hydroxybenzoate) were prepared and their use in harpoon was requested. Only one example was obtained but it could not be said to have been successful. The effect of this antiseptic is therefore, still unknown and further examinations are scheduled to be made.

The writers take this opportunity in expressing their deep gratitude to the members of the Technical Department and Akkeshi Office of Taiyo Fisheries Co., Ltd. for giving them facilities and extending them many valuable assistances during the course of this study. The writers are also grateful for valuable advices extended them by Messrs. H. Okuda and T. Nakai of the whales Research Institute, and to Messrs. T. Ohsawa, Y. Kuno, and Y. Nakaji for their cooperations in this work.

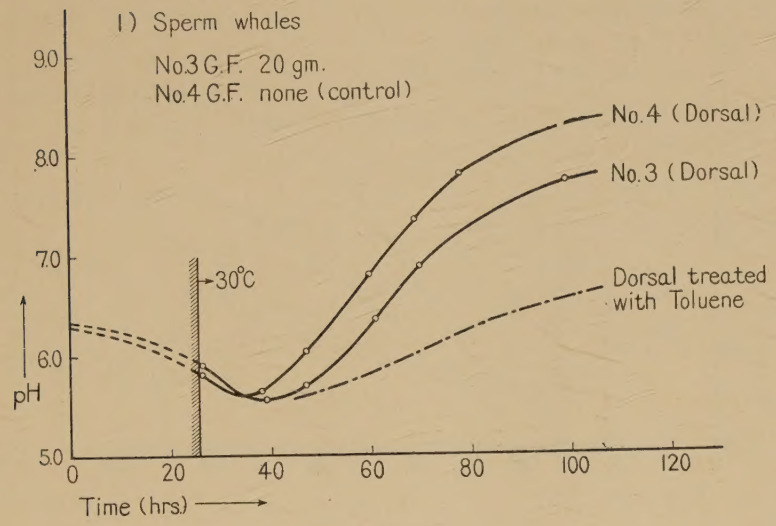
1) Sperm whales
No.3 G.F. 20 gm.
No.4 G.F. none (control)
No.4 (Dorsal)
No.3 (Dorsal)
Dorsal treated with Toluene
30°C
pH
9.0
8.0
7.0
6.0
5.0
0
20
40
60
80
100
120
Time (hrs.)

Fig. 3

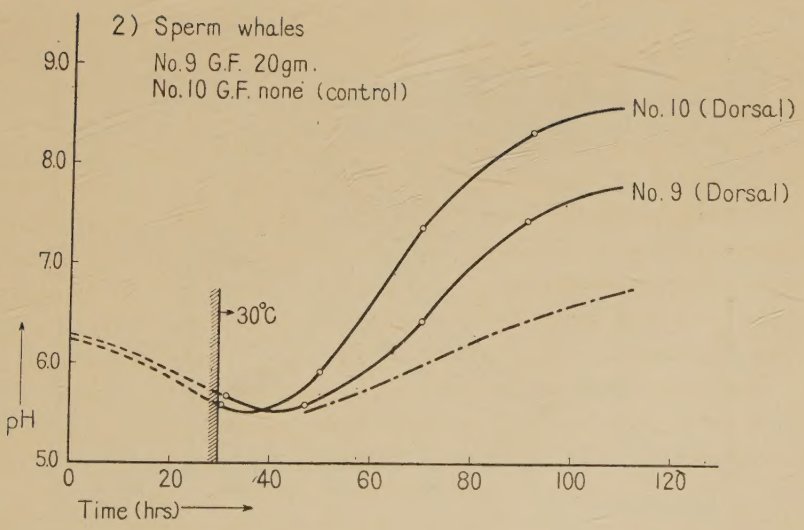
2) Sperm whales
No.9 G.F. 20gm.
No.10 G.F. none (control)
No.10 (Dorsal)
No.9 (Dorsal)
30°C
pH
9.0
8.0
7.0
6.0
5.0
0
20
40
60
80
100
120
Time (hrs.)

Fig. 4

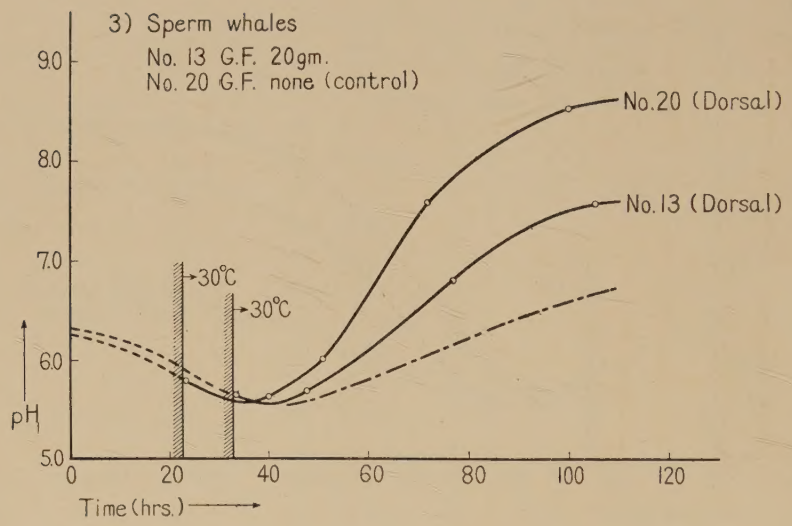
3) Sperm whales
No. 13 G.F. 20gm.
No. 20 G.F. none (control)
No.20 (Dorsal)
No.13 (Dorsal)
30℃
30℃
9.0
8.0
7.0
6.0
5.0
pH
0
20
40
60
80
100
120
Time (hrs.)

Fig. 5

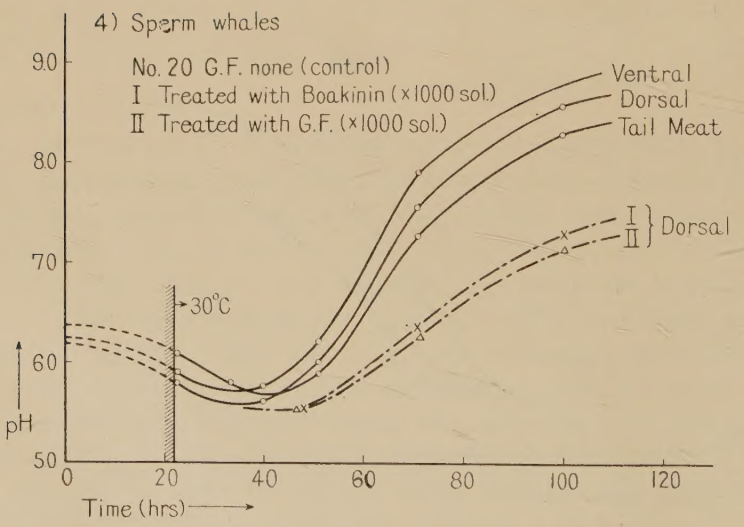
4) Sperm whales
No. 20 G.F. none (control)
I Treated with Boakinin (×1000 sol.)
II Treated with G.F. (×1000 sol.)
Ventral
Dorsal
Tail Meat
I
II
Dorsal
30℃
9.0
8.0
7.0
6.0
5.0
pH
0
20
40
60
80
100
120
Time (hrs)

Fig. 6

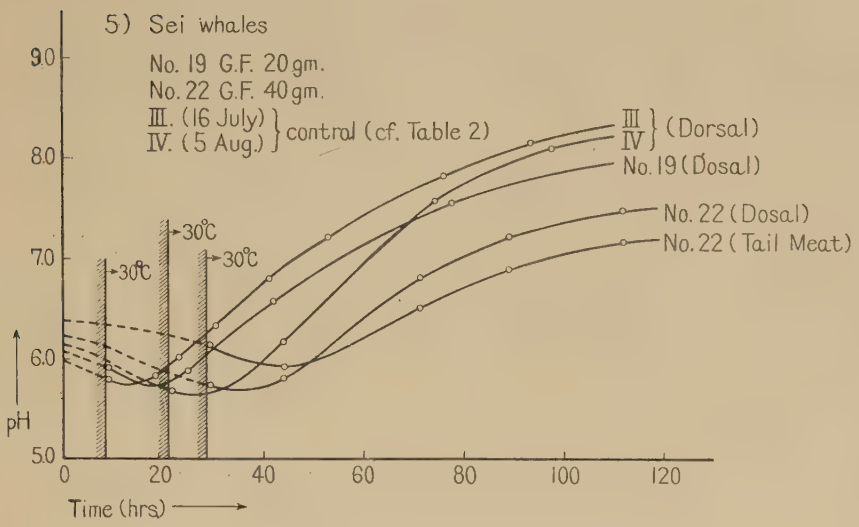
5) Sei whales
No. 19 G.F. 20gm.
No. 22 G.F. 40gm.
III. (16 July)
IV. (5 Aug.)
control (cf. Table 2)
III
IV
(Dorsal)
No. 19 (Dosal)
No. 22 (Dosal)
No. 22 (Tail Meat)
30℃
30℃
30℃
9.0
8.0
7.0
6.0
5.0
pH
0
20
40
60
80
100
120
Time (hrs)

Fig. 7

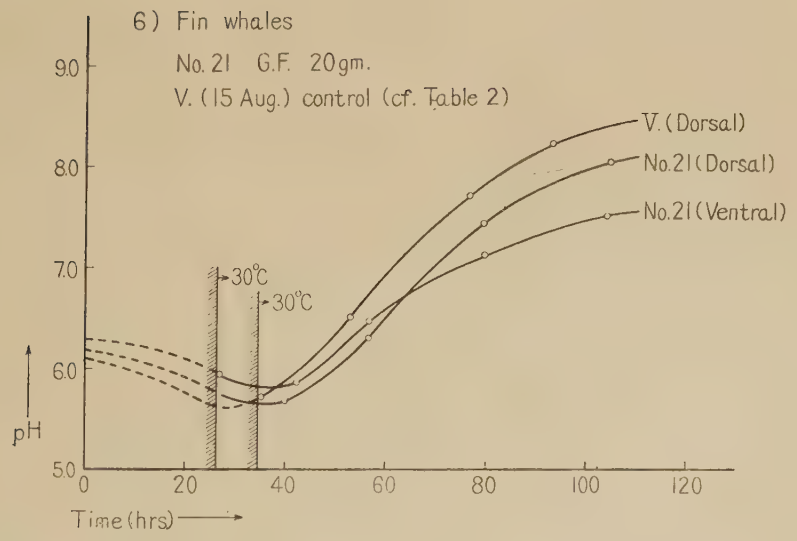
6) Fin whales
No. 21 G.F. 20gm.
V. (15 Aug.) control (cf. Table 2)
V. (Dorsal)
No. 21 (Dorsal)
No. 21 (Ventral)
30℃
30℃
9.0
8.0
7.0
6.0
5.0
pH
0
20
40
60
80
100
120
Time (hrs)

Fig. 8

Summary

Experiments on the preservation of freshness in whale meat with Guanofuracin (5-nitrofurfurylideneaminoguanidine hydrochloride) were carried out as 4th series of the these experiments at Akkeshi in the Hokkaido during July and August, 1953. Twenty-two cases, including 16 sperm whales, 5 sei whales, and one fin whale, were obtained of which about two-thirds were successful cases. Determination of pH value of the meat and blood level of Guanofuracin was carried out on the successful cases and on control whales and it was reconfirmed that the freshness of meat in Guanofuracin-injected whales was preserved to some extent compared to control whales.

Reference

1) S. Akiya, O. Hoshino, N. Motohashi: Sci. Rep. Whales Res. Inst., No. 7, 23 (1952).
2) S. Akiya, R. Sawamura: Sci. Rep. Whales Res. Inst., No. 7, 31 (1952).

(Pharmaceutical Institute, Medical Faculty, University of Tokyo)

On the Musculature of the Sinus Venosus and its Continuation with the So-called Conducting System of the Whale's Heart

By

Teizo Ogawa

I. Introduction

Since the *Stannius*' ligation experiments of 1852, the fact has ever been confirmed, that in lower vertebrates impulses starting in the sinus venosus control the rhythmic contractions of the whole heart. But the problem, where to seek for the sinus venosus in the mammalian heart, has never been concurrently answered. Mostly among physiologists the opinion prevails, that the sinus venosus is reduced to a high degree, and remains only miserably along the terminal sulcus of the right atrium, making the so-called sinus node. Other scanty remnants are said to exist at the orifices of the inferior cava, of the coronary sinus, and of the pulmonary veins. This theory has its origin without doubt in the famous work of *Keith* and *Flack*, who discovered then the sinus node (1907). Along with the progress of the cardiac physiology, more and more weight has been laid on the significance of the sinus node as "pacemaker," and it has become a usual trend among medical scientists, including sometimes anatomists, to think of the node itself as representing the sinus venosus.

But from the standpoint of anatomy, this way of thinking is rather a difficult one, and has relatively little convincing power. We are more inclined to believe, as we read in *Gray*'s textbook of the human anatomy (24. ed., 1946, p. 499), that the sinus venosus becomes incorporated with and forms a part of the adult atrium, the line of union between it and the auricula being indicated in the interior of the atrium by a vertical crest, the crista terminalis of *His*. Before 1907, such was probably the most common idea. As an example the following sentence is cited from the textbook of *Bardeleben* (1906), "Aus dem Venensinus und der primitiven Vorkammer wird später durch Vereinigung dieser Räume der Vorhof, noch später die beiden Vorhöfe, schliesslich finden wir beim erwachsenen Herzen den Venensinus als Hauptbestandteil der Vorhöfe, während die primitiven Vorhöfe (Vorkammern) zu den Herzohren reduziert sind."

In America *Glomset* (1940) mentioned very sceptically the existence

and significance of the sinus node, studying in detail the hearts of man and some mammals (cattle, horse, dog, pig). According to him, the so-called sinus node is never a part structurally so special as generally believed, because similar structure is found here and there in the walls of both atria, and at the atrio-ventricular groove too. Moreover *Glomset* insisted, that the extirpation experiments performed by previous scientists were not conclusive enough to speak definitely of the pacemaker function of the sinus node.

One chief reason, why the sovereignty of the sinus node is sometimes suspected, is probably the inconsistency between remarks of many researchers upon size, localisation, extension, and histological structure of the node. The far elongation of the sinus node observed recently by *Fukuhara* (1949, 1950) in dog, cat, and rabbit, and also by *Nomura* (1952) in mouse is not a little divergent from the reports of previous workers. Although one can explain this difference to a certain degree from the phylogenetic relation, we should remember at the same time *Takahashi*'s report (1931) on special muscle fibres at the orifice of the inferior cava and also *Thorel*'s paper (1910) on the wide distribution of the "Röhrenfasern." Both of them concerned the human heart; so phylogeny can not be estimated too much here.

In order to treat the problem further, the present author chose as the comparative anatomical means the Cetacean hearts. In the classical work of *Keith* and *Flack* (1907) hearts of two kinds of Delphinidae (porpoise and dolphin) and of the blue whale (Balaenoptera musculus) were studied. Simple as their descriptions concerning the Cetacea are, they must have recognized the sinus node in these animals. *White* and *Kerr* (1917) dissected out the atrioventricular system in the heart of Physeter and published macro- and microscopical photographs. In the same year *Ogata* (1917) made a speech upon the conducting system of whales' hearts (fin and sei whales) at a meeting of Japan Pathological Society. Two years later *Ogata* (1919) published together with *Sassa* their observation on special muscle bundles in the atria of the fin whale (Balaenoptera physalus) again at a meeting of the above mentioned society. Though only a three-page abstract was printed then for publication, it related the following very noteworthy facts.

Just under the epicardium they saw at the orifice of the coronary sinus special-looking muscles, which extend from here to the posterior surfaces of both atria, right and left. The right bundle reaches a place near the middle between superior and inferior cavae, and ends there, while the left one extends obliquely along the *Marshall*'s vein to termi-

nate near the left margin of the ostium of the left pulmonary vein. The bundles in question are lighter colored than the usual atrial muscles, and dispatch in their courses some branches, which are continuous directly with the usual muscles of the atrial wall. *Ogata* and *Sassa* called them "connecting bundles of the sinus venosus."

Dr. *Ogata*, now emeritus professor of our medical school, visited the present author in the University of Tokyo in the autumn of 1948, and encouraged the latter to study this problem, as he, being too busy, had no time to promote the thema by himself.

Since 1919, the attention of very few anatomists has been given to the heart of whales, so far as we consult the literature. In 1934 *Arpino* studied the innervation of the sinus node of Delphinus delphis, and in 1952 *Davies*, *Francis*, and *King* reported their results upon the cardiac nerves of Phocaena communis. Nobody has mentioned yet the special muscle bundles discovered by *Ogata* and *Sassa*.

II. Materials and methods

The hearts studied in the present work are mostly those of Odontoceti, in contrast to the Mystacoceti studied by *Ogata* and *Sassa*. About 10 hearts of the Pacific beaked whale (Berardius bairdii *Stejneger*) make here the most important material; also a few hearts of the sperm whale (Physeter macrocephalus *L.*) were examined. Macroscopical works were performed with knives and pincettes. Microscopical sections were prepared from various places of the hearts, cut sometimes by freezing, but in most cases embedded in paraffin or celloidin, and the sections were stained by hematoxylin-eosine, *van Gieson*'s, or *Bielschowsky*'s method.

III. Observations

A. Special muscle bundles seen in the atrial walls of Berardius bairdii

The hearts of Berardius treated in this work had got more or less lesions at the dissection of the whale bodies, so the observations were usually not completed in one individual, and sometimes it was necessary to fill up the defect in one heart with observations in other ones. Moreover it was perceived soon, the whole system of the special-looking atrial muscles shows not a few individual variations, though there is no essential difference between the cases. In the following, muscular figures of the posterior atrial wall will be described, based chiefly on case I.

Subepicardially, there is a remarkable muscular bundle (A), smoothly outlined, at the base of the coronary sinus. Deeply dissecting, it is easily seen, that it makes a muscular ring around the orifice of this sinus (figs. 1, 2). (In some individuals this ring formation is not complete; the part on the external side of the sinus is wanting or partially

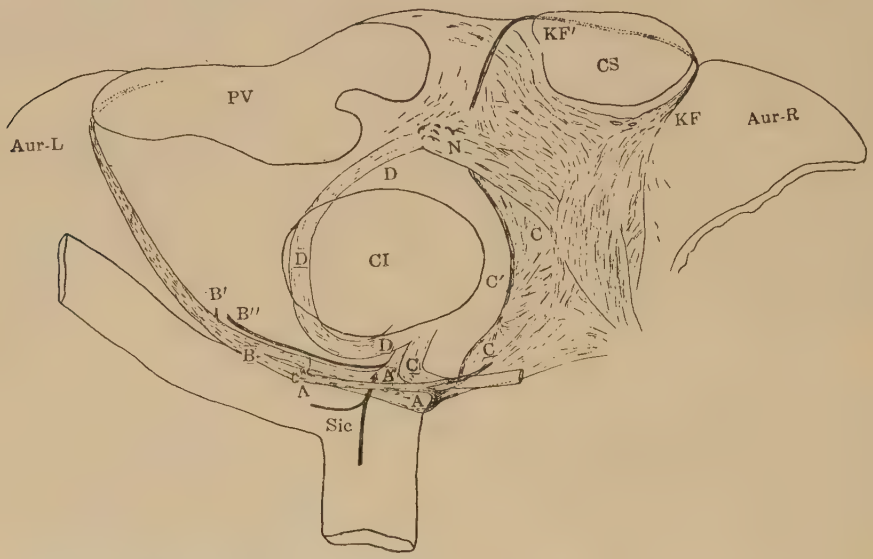

Fig. 1. Muscles of the sinus venosus in the heart of Berardius (case I)

Aur-L: left auricle
Aur-R: right auricle
CS: superior vena cava
CI: inferior vena cava
PV: a large defect in the left atrial wall involving the orifices of the right and left pulmonary veins
SiC: the arrow showing the entrance of the coronary sinus.
As to other letters, see the text or abbreviations of pages 20 and 21

interrupted.) It is darker colored than the usual atrial muscles, and so appears to be of a special nature. From this ring wings stretch out to both sides, right and left, and the right one continues directly to the lowest posterior part of the right atrium, just facing the atrioventricular groove.

The muscular ring dispatches on the external surface of the coronary sinus a remarkable branch (A'), which is directed to right and upwards, becomes soon narrower and terminates not far from the ring, attached to the posterior surface of the lower part of the right atrium (figs. 1, 2). Here no direct continuation to the ordinary atrial muscles is proven.

Minutely examined, the special-looking muscular bundle changes at the terminal to slender tendon-like connective tissue and ends by means of this in contact with the atrial muscles. The terminal sulcus of *His* lies far more laterally; so A and A′ belong to the musculature of the sinus venosus, according to our definition.

Fig. 2. A portion of fig. 1, near the entrance of the coronary sinus (the arrow from below). The arrow on the right side shows a vein entering the right atrium after passing along the atrioventricular sulcus.

The left wing of the muscular ring is a large assembly of muscular bundles (B) extending obliquely along the *Marshall*'s vein to left and upwards on the posterior surface of the left atrium, and attaining the angle between the left pulmonary vein and the left auricle (figs. 1, 2). During the course it becomes gradually thinner, but as a whole it is very thick and powerful, incomparable to A′. It appears darker red than the usual atrial muscles. Only one small branch (B′) issues from it and ends very soon upon the posterior surface of the left atrium. There is another very thin isolated bundle (B″), which runs parallel and internal to B, restricted only to a distance relatively near the coronary sinus. The bundle B terminates at the lateral margin of the left pulmonary vein; here too we see no direct transition between B and the ordinary atrial musculature.

From the floor (i.e. internal) part of the muscular ring at the orifice of the coronary sinus stretches forwards a triangular broad process (A″), which submerges under C+D later to be mentioned (figs. 1, 2). As the *Tawara*'s node lies just beneath C+D, A″ shows an intimate relation with this node. The relation will be mentioned more precisely in the next chapter.

Special muscular bundles discovered by *Ogata* and *Sassa* in Balaenoptera correspond very probably to A, A′, and B, B′ of the present paper, though there are some disagreements due at least partially to taxonomic difference. They say the bundles in question are lighter colored than the ordinary atrial muscles, and dispatch many branches directly continuous with the atrial musculature. These remarks are contradictory to the present paper. Only rarely, in one among five specimens, *Ogata* and *Sassa* could see no branching of the bundle. Besides, these authors traced the right bundle to about the middle between superior and inferior cavae, therefore very different from A or A′. But again in one among five hearts studied by them the special bundle did not reach so far. Moreover no ring formation was mentioned in their paper of 1919.

In Berardius anothor well-defined, slender but long muscle bundle (C′) is very marked ; it runs laterally and below to the entrance of the inferior cava, assuming an arcuate form. It is darker colored than the ordinary atrial muscle, but a little lighter than A and B. C′ makes clearly the left marginal portion of a broad, sickle-shaped muscle plate (C), which is the leftmost part of the posterior right atrial wall (fig. 1). When traced mediad and downward, united mass of C′ and C is seen on the interior of the atrium, making here a single broad, subendocardial muscular plate (C), which, from a dextrocranial direction, attains the floor of the entrance of the coronary sinus just anterior to A, always a little apart from this. Mixing of muscle fibres does not occur between A and C. As will be related later, C shows the most intimate connection with the *Tawara*'s node.

Upwardly observed, C′ reaches between superior and inferior cavae, hides itself there under other atrial musculature, and disappears near a certain place of the right atrium, where many atrial muscles are concentrated (fig. 1). This concentration area of the atrial musculature lies covered by the right pulmonary artery and behind the *Bachmann*'s interauricular bundle ; it is very near the anterior upper end of the atrial septum. The present author would call this node-like part of hte right atrial wall with the abbreviation of " N ", and takes it for a

portion of the "septal raphe" reported previously by *Papez* (1920).

In case I, "N" shows darker red tone than the ordinary atrial parts, and, being wrapped by thick connective tissue, it was relatively difficult to excise the epicardium here. Besides, the author would lay much stress on the rich innervation of this area, as in the formerly published work (*Ogawa*, 1952) he could trace in Berardius as well as in other Cetacea just under the right pulmonary artery many nerves of vagal and sympathetic components coming from right and left sides. In one Berardius heart (case III), which belonged to a 250 cm long, female foetus, C′ did not reach "N", but ran laterad after it sank from the posterior surface at a place between superior and inferior cavae toward the terminal sulcus. But its connection with the sinus node was not proven.

With "N", i.e. the node-like area, there is continuous a large group of atrial muscles, which run dextrocaudally in a slightly opened fan-like form between superior and inferior cavae to make a broad muscular area limited laterally by the sulcus terminalis (fig. 1). The *Lower*'s torus is caused chiefly by this muscular mass, but the most medial part of the torus is made by the already mentioned C, while the continuance of the *Bachmann*'s bundle, coming partly behind the orifice of superior cava, participates in making the lateral part of this torus.

Moreover a broad, well-defined muscular bundle (D) starting from "N" goes downward into the atrial septum, and forming the posterior margin of the oval fossa attains from sinistrocranial the floor of the right atrium just in front of the coronary sinus (fig. 1). There the fibres of C and D are mixed partly. Just beneath C+D lies the *Tawara*'s node embedded in hard connective tissue. The septal nerve (S), reported in the previous paper (*Ogawa*, 1952), courses together with D.

The presence of the sinus node is in Berardius not always certified. In case I, at the groove between the superior cava and the right auricle a dark red, thin bundle (KF′) is present, runs anteriorly surrounding the entrance of the superior cava, and crosses over the *Bachmann*'s bundle on the left side of this vein and reaches near "N", there disappearing. This special-looking bundle forms at the posterior margin of the superior cava a rounded mass (KF), which corresponds probably to the sinus node (fig. 1). This mass shows direct connection to the left side with the *Bachmann*'s bundle and downward with muscles of the broad area just medial to the terminal sulcus. But no direct intercourse between this probable sinus node and the *Tawara*'s node is seen,

In case II (33 feet long, adult male Berardius) the upper part of the terminal sulcus, where the sinus node according to *Keith* and *Flack*'s paper certainly has to exist, was microscopically examined, but the efforts of finding it were in vain.

B) *Tawara*'s node and its direct continuance with the atrial musculature

In several cases of Berardius the author dissected out the *Tawara*'s node and was in every case much impressed by its direct continuance with C and D of the foregoing chapter, above all on a larger scale with C. Transition from C and D to the node in question occurs completely gradually, without any appreciable boundary. Muscular fibre groups diverge out downward from C and D at the floor of the right atrium

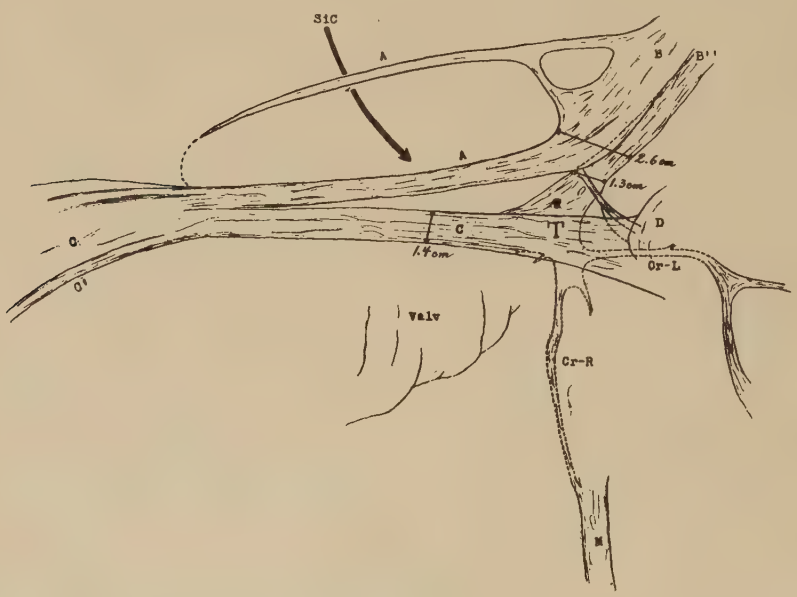

Fig. 3. Macroscopical relations of the *Tawara*'s node (T) of Berardius (case IV), seen from the interior of the heart

SiC: Sinus coronarius
Valv: Valvula tricuspidalis (Cuspis posterior)
M: Moderatorband
Cr-R: right crus of the *His*' bundle
Cr-L: left crus of the *His*' bundle

in front of the coronary sinus, and intermingle with hard connective tissue; muscular fibres run here not straight but more irregularly, are loosely assembled, plexiform with many collagenous fibres between them

(figs. 5, 6). They are cross-striated. In fresh material the node looks macroscopically as diluted red ink infiltrating in white connective tissue. Direct continuation of muscular fibres between the node and the atrial muscles is under microscope very clearly demonstrable in serial sections of this region taken from case IV (figs. 5, 6). In these sections, made as large as possible to include various parts of atrial walls and of the conducting system, one can easily trace the gradual change of the histological structure within the conducting system formed by the union of atrial muscles (figs. 6, α; 6, β), *Tawara*'s node (fig. 6, γ), and *His*' bundle (fig. 6, δ) with its crura (figs. 6, Cr-R; Cr-L).

Not only C and D but also A and B, which are the special-looking muscles surrounding the coronary sinus, and extending along the *Marshall*'s vein, contribute to the formation of the *Tawara*'s node, especially remarkable for A'' and B''.

In case IV the *Tawara*'s node relatively clearly dissected out shows, from cranial seen, a triangular outline, three angles of which are made respectively by B'', C, and D (fig. 3). Even in other cases, when the boundaries of this node are not so clear, one can easily confirm the node by searching at first for the right and left crura of the *His*' bundle. The crus commune is short and macroscopically not discernible from the node itself. Only histologically one can speak substantially about the border, which is but never a sharp one. The discrimination between "Vorhofsabschnitt" and "Ventrikelabschnitt" insisted by *Aschoff* is also not impossible in microscopical preparations.

One thing to be especially noted is, that just under the connective tissue surrounding the *Tawara*'s node the ventricular musculature lies. It tells namely, this node is located not at a place relatively near the interior surface of the right atrium or in the atrial septum, but theoretically on the outer surface of the right atrium. This applies probably to the hearts of man and other mammals too; only in whales the relation is easily recognizable, as both atria are in this animal widely apart posteriorly from each other. *Ogata* (1917) wrote already this fact with great interest in Balaenopteridae.

The *Tawara*'s node of Berardius receives abundant nerve bundles, coming here mostly from the left side through the fossula cordis nervina of *Belowa* as continuation of nerves along the *Marshall*'s vein (F of the former paper) and of the septal nerve (S of the former paper) (cf. *Ogawa*, 1952). In microscopical sections we see here and there in the courses of these nerves groups of ganglion cells chiefly on the left side of and below the node. Some of the nerves go directly into the crura of *His*'

bundle. Until near the end of the crus commune groups of nerve cells are observed (fig. 6, δ).

C. *Tawara*'s node of Physeter

Case VI is the heart of a ca. 35 feet long sperm whale, Physeter macrocephalus, the *Tawara*'s node of which was dissected out solely and was compared with that of Berardius. Many identical relations were proven. Also in Physeter the node in question is largely connected with C-bundle, which comes down from right upper direction to the floor of the right atrium in front of the coronary sinus, and with D-bundle, which descends in the atrial septum down to the same locality. Especially the former shows the nearest topographical and the most intimate relation with the *Tawara*'s node. No sharp boundary exists between C+D, and the node.

Besides, the dark colored, special-looking muscle (A) at the orifice of the coronary sinus, which does not form a ring, differing from case I of Berardius, but continues directly to a large group of the special-looking muscles along the *Marshall*'s vein (B), gives off forward a remarkable process (A''), which submerges beneath C+D, and goes partly directly into the formation of the *Tawara*'s node. This node can with no difficulty be found, firstly by seeking crura of the *His*' bundle and following them to the short crus commune, which shows no macroscopical boundary against the node itself, secondly by rich existence of connective tissue embedding the node, and thirdly by a number of nerve bundles coming to the node from posterior surfaces of both atria.

White and *Kerr* (1917) mentioned the vertical direction of the *Tawara*'s node and of the *His*' bundle in Physeter, which coincides well with the present author's observations not only in the sperm whale, but also in Berardius. But more important is perhaps the position of the *Tawara*'s node, that it lies certainly on the outer surface of the right atrium.

The *Tawara*'s node of Physeter receives several nerve trunks, of which the author calculated six in case VI, from posterior surfaces of both atria, passing more on the right side, less on the left side of the orifice of the coronary sinus, a remarkable contrast to Berardius. In the latter species most of the nerves, as already related, pass on the left side of the coronary sinus. This difference is well to be explained from the deficiency of the septal nerve in Physeter ; the homologon of the septal nerve descends in this species on the posterior surface of the right atrium mostly on the right side of the inferior cava.

In the *White* and *Kerr*'s paper we see only one nerve trunk attaining the *Tawara*'s node. This was not the case in all the hearts of Physeter studied in the present paper. These authors' description and photograph on the auriculonodal junction are very interesting, though they did not tell at all, with what part of the atrium this junction occurs.

IV. Comments

a) The sinus venosus in the mammalian heart

From phylo- and ontogenetical viewpoints, it is very difficult to conceive that in the mammalian hearts the sinus venosus remains in so vestigial a state, being restricted to such small areas as the sinus node of *Keith* and *Flack* and to several other places at venous entrances. On the contrary, most anatomists think, that the so-called sinus venarum, which is a large medial portion of the right atrium, bordered laterally by the terminal sulcus or crest and, where the cavae veins and the coronary sinus enter the atrium, corresponds to the sinus venosus of lower vertebrates.

In regard to the extent of the sinus venosus, *Walmsley* wrote in his excellent book (1929) the same opinion as ours, but he added further, "the musculature of the sinus wall, which is never well developed, appears to be replaced by the musculature of the atrium, and there remain, as sinus musculature, only the fibres, or at least some of them, which surround the terminal part of the superior cava and those in the wall of the coronary sinus" (p. 37). The present author cannot be certain about the replacement mentioned by *Walmsley*, whose words sound rather as a compromising hypothesis between divergent ideas of anatomists and physiologists. On the other hand, nobody doubts the large existence of the bulbus arteriosus as a part of the right ventricle making the so-called conus arteriosus. And what is the reason, why we must think of so poor an existence of the sinus venosus musculature in the mammalian heart?

The reason is probably the following. Many authors have clung to the idea, that the parts homologous to the sinus venosus must have the structure similar to the *Tawara*'s node. They searched earnestly for the sinus upon this basis, and found it at the terminal sulcus and some other places. But the present author takes this assumption as not justified, and thinks, that many muscular bundles mentioned in this work, A, A′, A″, B, B′, C, C′, D, KF etc. belong altogether to the sinus

venosus, because all of them are situated more medially than the terminal sulcus.

There is no need to be very anxious about relatively less similarity between the *Tawara*'s node and the muscles in question, though at least it is true that the latter contain rich connective tissue and many nerves, as we realized on the other hand in serial sections of the heart of a Bufo, that muscles of the sinus venosus are more loosely constructed, having more connective tissue between muscle fibres, compared with the auricular and especially with ventricular musculature.

Moreover, the present author has reached the opinion, that the centre of the sinus musculature thus defined lies not in the so-called sinus node of *Keith* and *Flack*, but at a certain place ("N") more sinistral than the entrance of the superior cava, and a little posterior to the *Bachmann*'s bundle. It is near the anterior upper end of the atrial septum. Many of the atrial musculature are concentrated here.

It makes probably a part of the septal raphe described by *Papez* (1920) in human, bovine, and canine hearts, though his "septal raphe" seems to be more deeply located in the atrial wall and generally lower in height than "N" of this work. According to him, the sinus node itself is nothing more than a continuation of the septal raphe, but the special histological structure of the nodal tissue is not seen in the septal raphe. *Papez* traced many branches from the right vagosympathicus to this locality, so the question arose to him, whether this might have the pacemaker function for all the left atrium and for the deeper layer of the right atrium. But without mentioning the reason, he seemed to have abandoned this idea, because we read at another place in his paper the septal raphe has only the meaning of mechanical support for the atrial musculature.

The present author deems, the physiological meaning of "N" should be considered more seriously, for as reported formerly (*Ogawa*, 1952), vagal and sysmpathetic nerves not only from the right side, as *Papez* said, but also from the left side attain this place in a large number and so "N" makes apparently a more special locus, than the sinus node, where relatively few nerves starting only from the right side are traceable.

Recently *Uchiyama* and his collaborators have endeavoured to determine in the anuren hearts the centre of automatism within the whole extent of the sinus venosus, "node of venous sinus, Venensinusknoten". This way of thinking is very important in the cardiac physiology, and "N" of us seems to have an intimate relation with *Uchiyama*'s "node

of the venous sinus". Physiological experiments upon "N" must be done hereafter, though they may be relatively difficult to perform, as it lies concealed under the right pulmonary artery.

b) On the so-called sinus node

As to the problem, whether the sinus node of *Keith* and *Flack* be the most important portion of the sinus venosus in the mammalian hearts, the present author cannot stand on the affirmative side. In Berardius he observed occasionally at the groove between the superior cava and the right auricle dark colored muscle bundles, which correspond almost certainly to the so-called sinus node. They showed however in form and extension much individual variations, and in some cases they are not found at all. *Glomset*'s scepticism upon the existence and meaning of this node was already introduced at the beginning of this paper. The present author would say accordantly with him, that the so-called nodal tissue is not confined to such small areas as the sinus node and to orifices of other veins entering the atria, but shows a much wider distribution in the atrial walls.

Richness of nerves is never a characteristic for the so-called sinus node, though this attribute is quite naturally expected for the pacemaker of the cardiac actions. Together with *Papez*, the present author would indicate much more abundant nerves attaining the septal raphe, than reaching the sinus node.

Since *Lewis*' electrocardiographic works the pacemaker function of the sinus node has been insisted by a great many authors, but according to *Glomset*'s criticism "most experiments on ablation of the sinuatrial node fail to show convincingly that the node is the pacemaker of the heart"; he introduced then the works of *Flack*, *Jaeger*, *Magnus-Alsleben*, *Moorhouse*, *Brandenburg* and *Hoffmann*, *Eyster* and *Meek*, and *Borman*, and added further that "there is no unanimity of opinion as to location, size, and structure of the node".

c) On the connecting bundles of the sinus venosus discovered by *Ogata* and *Sassa*

Ogata and *Sassa* supposed as the functional meaning of the "connecting bundles of the sinus venosus" (A and B of this paper), that as the venous entrances must have been closed before the contraction of both atria begins, the bundles in question might convey impulses for the contraction to the venous entrances, and that though their morphological studies had not yet revealed the direction, they assumed basing on general structure, that the bundles might have the function

to conduct impulses arising at the coronary sinus to the venous entrances of both atria.

The present author cannot altogether agree about this assumption, because in Berardius no direct relation with the venous orifices, except with the coronary sinus, is ascertained, and too many individual differences are seen in the course, extension, and size of the bundles in question, to permit thinking of such important function. But they make surely a part of the sinus venosus, and must have intimate relation embryologically with the left horn of the sinus venosus (fig. 8), while

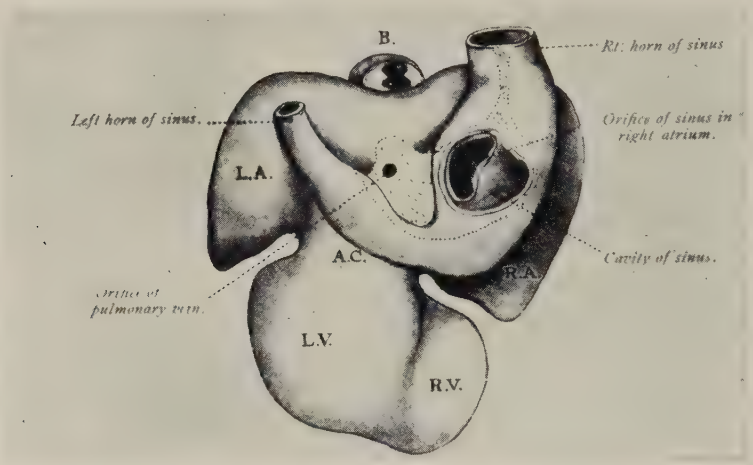

Fig. 8. The heart of a human embryo, from behind. (*Walmsley* 1929, drawn after the model of *His*) B., bulbus cordis; A.C., atrial canal; L.A., R.A., left and right atria; L.V., R.V., left and right ventricles.

the above mentioned C and D together with KF seem to belong to the embryologically better developed right horn and to the middle part of the sinus venosus. Moreover, if we read the detailed descriptions of *Papez* (1920) on the musculature of the coronary sinus, we know that the presence of A and B can not be taken as a characteristic for Cetacea, as he wrote "in the bovine heart the sinus is a continuation of the left common cardinal system and is surrounded by musculature for a distance of several inches" (p. 271).

d) Upon the direct continuity between the muscles of the sinus venosus and the *Tawara*'s node

In the heart of Berardius a broad muscular band (C+C′), which arising near "N" and passing dextral to and below the orifice of the

inferior cava, reaches in front of the floor of the coronary sinus, and another broad muscular band (D), which starting also from "N" descends through the atrial septum, and meets with C in front of the floor of the coronary sinus, show very clearly direct transition into the *Tawara*'s node. This node is situated embedded in thick connective tissue just under the two muscular bands meeting together. Besides,

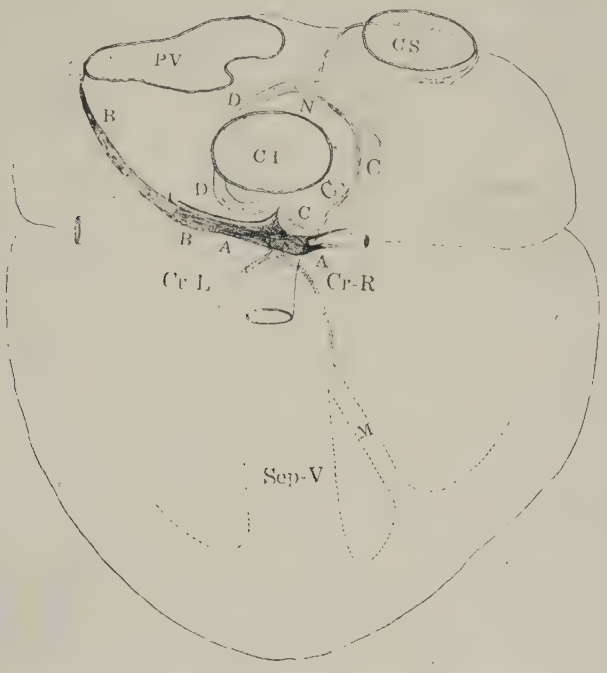

Fig. 9. Schema showing the whole musculature of the sinus venosus continuing directly to the so-called conducting system

A and B show also direct continuity with the *Tawara*'s node, by means of A'' and B''. Between A'' and B'' a compensatory relation seems to exist, as when A'' is largely developed B'' is small, and vice versa. So we can reckon three sources of muscular fibres streaming into the *Tawara*'s node, A+B, C, and D; this means the node in question receives its muscle fibres from all parts of the sinus venosus, not only from the right horn but also from the left one. In the sperm whale, too, nearly the same relations are proven.

Similar facts have already been reported by *Curran* (1909) in the calves' and sheep's hearts. He said that three large bands "radiate" out from the *Tawara*'s node: 1) "a branch to the interauricular septum

and proceeding almost as far as the superior cava where it is lost in the auricular musculature". This branch may correspond to our D, though according to *Curran*'s figure (Anat. Rec. Vol. 3, 1909, pl. I, fig. 1) most of the fibres in question are passing in front of the oval fossa. And also in Berardius some fibres pass probably anterior to this fossa. 2) "a branch, which can be traced to the pericardial surface of the right auricle, blending with the auricular muscle as it proceeds on its way to the pectinate muscles of the right auricular appendix". This resembles our C, though there is a difference, that C does not extend so far dextral as the pectinate muscles. 3) "a similar branch going to the left auricle—it gives some branches to the coronary sinus". This is perhaps A+B of this work. According to *Curran*, moreover numerous smaller branches radiate from the *Tawara*'s node to adjacent auricular muscle. The present author wishes to oppose *Curran*'s using of the word "radiate", because the muscle fibres seem to concentrate from the sinus venosus to the node in question.

Though *Curran* observed in the human hearts only fine threads, but no large branches of muscle radiating from the node to the atrial musculature, *Holl* (1912) wrote, when he studied macroscopically hearts of man, and some mammals (calf, sheep, pig, horse, dog) that "das (atrioventrikulare) Bündel nimmt mit einem Faserwerk in der Wandung des Sinus coronarius und wahrscheinlich auch in den benachbarten Wandungsstellen des rechten (und linken?) Vorhofes seinen Anfang; diese Fasermassen bilden ein Netzwerk *Tawara*'scher Knoten)". This remark of *Holl* is altogether adopted by *Rauber-Kopsch* in their famous textbook of anatomy (16. Aufl., Bd. 2, 1941, S. 384); so students must know this very commonly. Only the origin or course of the atrial muscle fibres connecting with the *Tawara*'s node has not yet been determined. Ambiguity of the origin or course is bluntly expressed in *Spalteholz*'s textbook (13. Aufl., 1933, S. 451). "Es beginnt . . . . , meistens mit einer Verdickung (*Tawara*'scher Knoten), in welche aus der Vorhofsmuskulatur (namentlich von der Gegend unter der Mündung des Sinus coronarius) Züge unsicherer Herkunft einstrahlen".

Chiefly from the observations in Berardius, the present author believes to have known the "Herkunft" of the atrial muscles connecting with the *Tawara*'s node in the Odontoceti.

e) On the *Tawara*'s node and the *His*' bundle

There are many anatomical data to assume the functional importance of the *Tawara*'s node. But this node never makes the upper end

of the so-called conducting system, never begins abruptly in the right atrium or in the atrial septum. It is continued directly from both horns and middle part of the sinus. Just in front of the floor of the coronary sinus, where embryologically the spina vestibuli is to seek, a certain portion of the sinus venosus muscles becomes loose downwards, and is surrounded by and interwoven with a large amount of hard connective tissue. Here we see a remarkable reticulum of muscular fibre groups embedded in the connective tissue. Nerve bundles reach this node, and show intimate relation with the reticular muscle fibres, as seen by the *Bielschowsky*'s method. Groups of nerve cells were observed here and there near the node, but few between the reticular muscular fibre groups.

Transition from this node to the *His*' bundle takes place again quite gradually. Within the atrioventricular bundle, muscle fibres, swollen like those of the bovine heart, ran parallel to each other, being embedded in a large mass of connective tissue. Many nerve fibres are seen following the *His*' bundle, and groups of nerve cells exist only as far as the end of the crus commune, but not after its bifurcation.

The moderator band of the right ventricle and the left crus a little below the semilunar valve in the left ventricle, were examined histologically, with the results, that the chief constituent of the crura of the *His*' bundle is the dense connective tissue containing collagenous fibres in a large quantity. The swollen muscular fibres and more or less large groups of nerve fibres are contained within the rich connective tissue. Compared with the neighbouring ventricular myocardium, sparseness of muscle fibres and richness of nerve fibres must be taken as characteristic of the *His*' bundle.

Abundance of nerve fibres in the *His*' bundle of the Cetacea was recently reported by *Davies*, *Francis*, and *King* (1552) in the common porpoise (Phocaena). They met with similar relations only in ungulates, but not in many other sorts of mammals. In the latter cases the authors saw many nerves only as far as *Tawara*'s node. This great difference between animals mentioned by them requires detailed reexamination, because *Nomura* in the same year (1952) demonstrated by photographs (plate 8, figs. 40–42) a rich content of nerve fibers in the *His*' bundle of the mouse. It may be an interesting problem to determine, whether so remarkable diversity really exists between the hearts of mouse and rat, two members of the genus Mus, just as the gall bladder exists in the former, but not in the latter.

V. Summary

1. Observed in the hearts of Berardius, the "connecting bundles of the sinus venosus" described by *Ogata* and *Sassa*, are a special portion of the sinus venosus musculature, belonging to the coronary sinus and to the *Marshall*'s vein, in other words, nothing more than the musculature pertaining to the left horn of the sinus venosus.

2. The middle part and the right horn of the sinus venosus are by far better developed, occupying a wide field of the right atrium bordered laterally by the terminal sulcus, never so vestigial as many authors have thought since the *Keith* and *Flack*'s discovery of the sinus node.

3. Within the thus-defined sinus venosus, there is a centre of the musculature "N", where many atrial muscles are concentrated, in the posterior upper part of the right atrium, left to the entrance of the superior cava, and behind the *Bachmann*'s interauricular bundle, covered above by the right pulmonary artery. This centre is probably a portion of the "septal raphe" reported by *Papez*. Here reach, as mentioned in the former paper (*Ogawa*, 1952), a large number of cardiac nerves, vagal as well as sympathetic branches, not only from the right but also from the left side. Anatomically it may be possible to postulate, that the so-called pacemaker is located at this place.

4. The presence of the sinus node of *Keith* and *Flack* is not always proven in Berardius, and even in cases of being present, it shows too much individual variation in size, form, etc. to have attributed to it such a great functional significance. Sometimes this node is continuous directly to "N" by a thin muscular bundle, surrounding anteriorly the orifice of the superior cava.

5. Connecting directly "N" and the *Tawara*'s node, there are two large groups of atrial muscles belonging both to the sinus venosus, one group (C) in an arcuate form on the right side of the orifice of the inferior cava, the other (D) descending within the atrial septum along the posterior margin of the oval fossa. Both of them meet together in front of the floor of the coronary sinus. And just under this meeting place the *Tawara*'s node lies, embedded in dense connective tissue and receiving a large number of nerve bundles, which come here in Berardius chiefly from the left side, continued partly from the septal nerve, partly from the nerves along the *Marshall*'s vein.

6. The muscular reticulum of the *Tawara*'s node is directly con-

tinuous with the muscle fibres of C and D; the relation is clearly demonstrable not only by naked eye but also under microscope. The "connecting bundles of the sinus venosus" of *Ogata* and *Sassa* (A+B of this work) show also partly direct muscular continuation with the *Tawara*'s node. So the presence of three muscular bands "radiating" from the reticulum to the atrial walls insisted by *Curran* in his work upon calves' and sheep's hearts were also proven in the Odontoceti.

7. The *Tawara*'s node of Berardius and Physeter, vertically placed, lies theoretically on the posterior surface of the right atrium just above the ventricular musculature, and is so to speak the middle part of an extensive cardiac muscular system (fig. 9), which begins above, embracing widely the sinus venosus, and continues downward directly to the *His*' bundle, to its right and left crura, and at last to the *Purkinje*'s fibres. Direct continuation and gradual histological change of muscle fibres in this whole system are seen clearly in the hearts of whales treated in this work.

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Abbreviations for figs. 1–9.

A, A′, A″: Musculature at the entrance of the coronary sinus
Aur-L: Left auricle
Aur-R: Right auricle
B, B′, B″: Musculature along the *Marshall*'s vein
C, C′: Muscular bundle descending on the right side of the inferior cava to the floor of the right atrium in front of the coronary sinus
D: Muscular bundle descending through the atrial septum to the floor of the right atrium in front of the coronary sinus
C+D: Meeting place of C and D, in front of the coronary sinus
CI: Inferior vena cava
Cr-C: Truncus of the *His*' bundle
Cr-L: Left crus of the *His*' bundle
Cr-R: Right crus of the *His*' bundle

CS: Superior vena cava
KF, KF′: Sinus node of *Keith* and *Flack* (very probably) and its continuance
M: Moderatorband=Trabecula septomarginalis
N: Node-like portion of the right atrium, where many muscles belonging to the sinus venosus are concentrated
PV: Orifices of the right and left pulmonary veins and vestibule of the left atrium
SiC: Sinus coronarius
T: *Tawara*'s node
Valv: Valvula tricuspidalis

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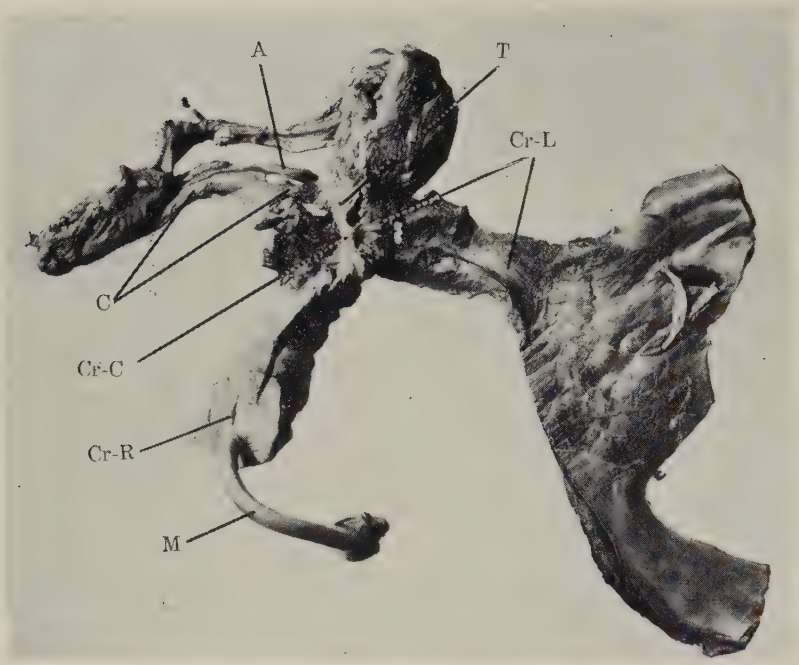

Fig. 4. (a) Macroscopic specimen showing the whole of the conducting system (Berardius, case IV).

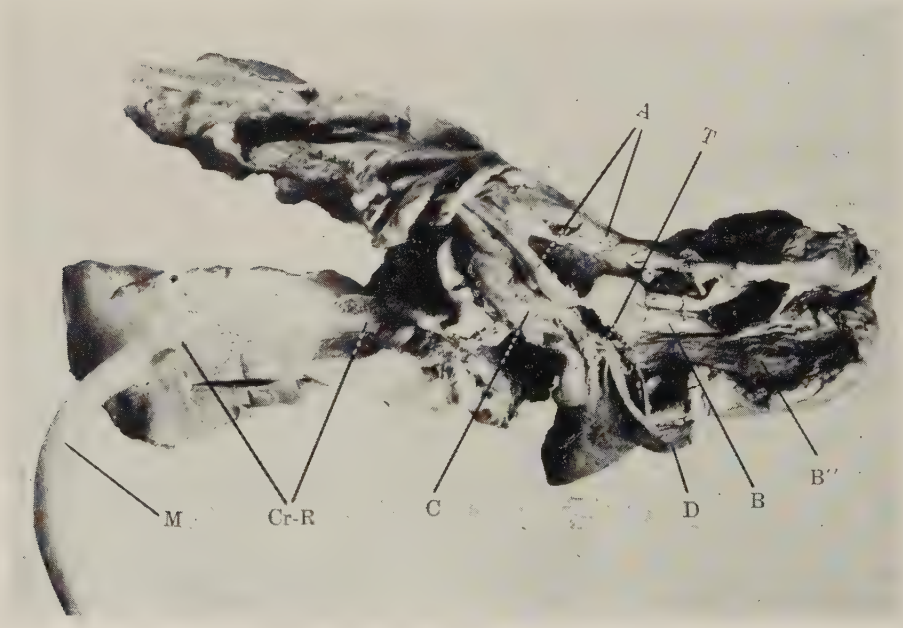

Fig. 4. (b) The *Tawara*'s node and the right crus of the *His*' bundle, seen from above (Berardius, case IV).

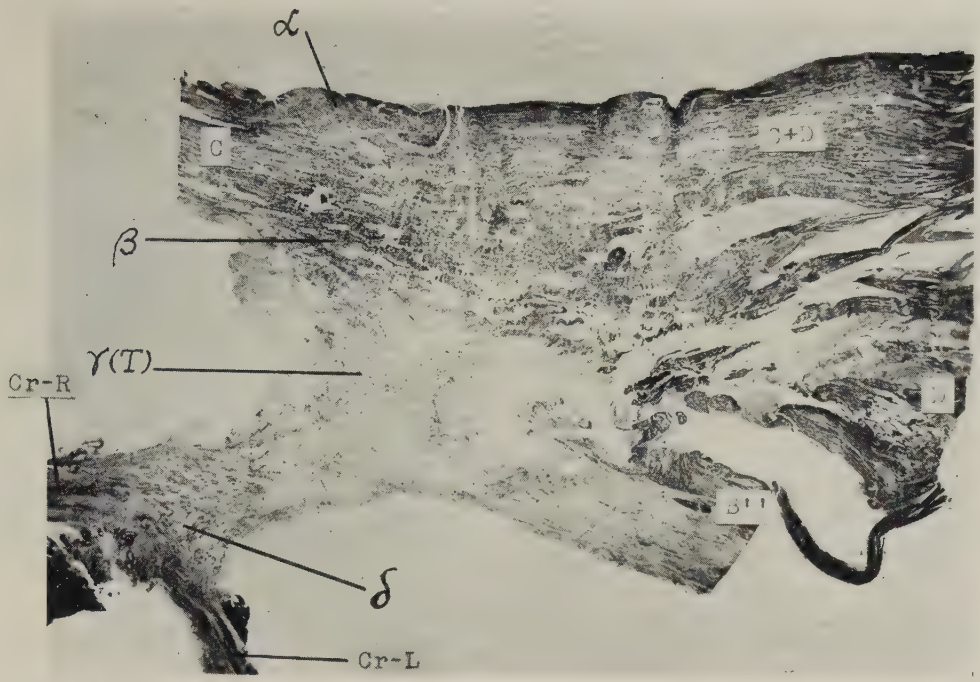

Fig. 5. (a) A microscopical section from the heart of Berardius (case IV) showing the *Tawara*'s node (T) and its neighbourhood. Note the direct continuance of muscular fibre groups of C into the node, and further into the *His*' bundle. α, β, γ, δ, Cr-R, Cr-L mean that the photographs of fig. 6 were taken about from these localities.

Fig. 5. (b) Another section belonging to the same series as (a).
T: *Tawara*'s node
*: transition between C and the node
**: transition between B″ and the node

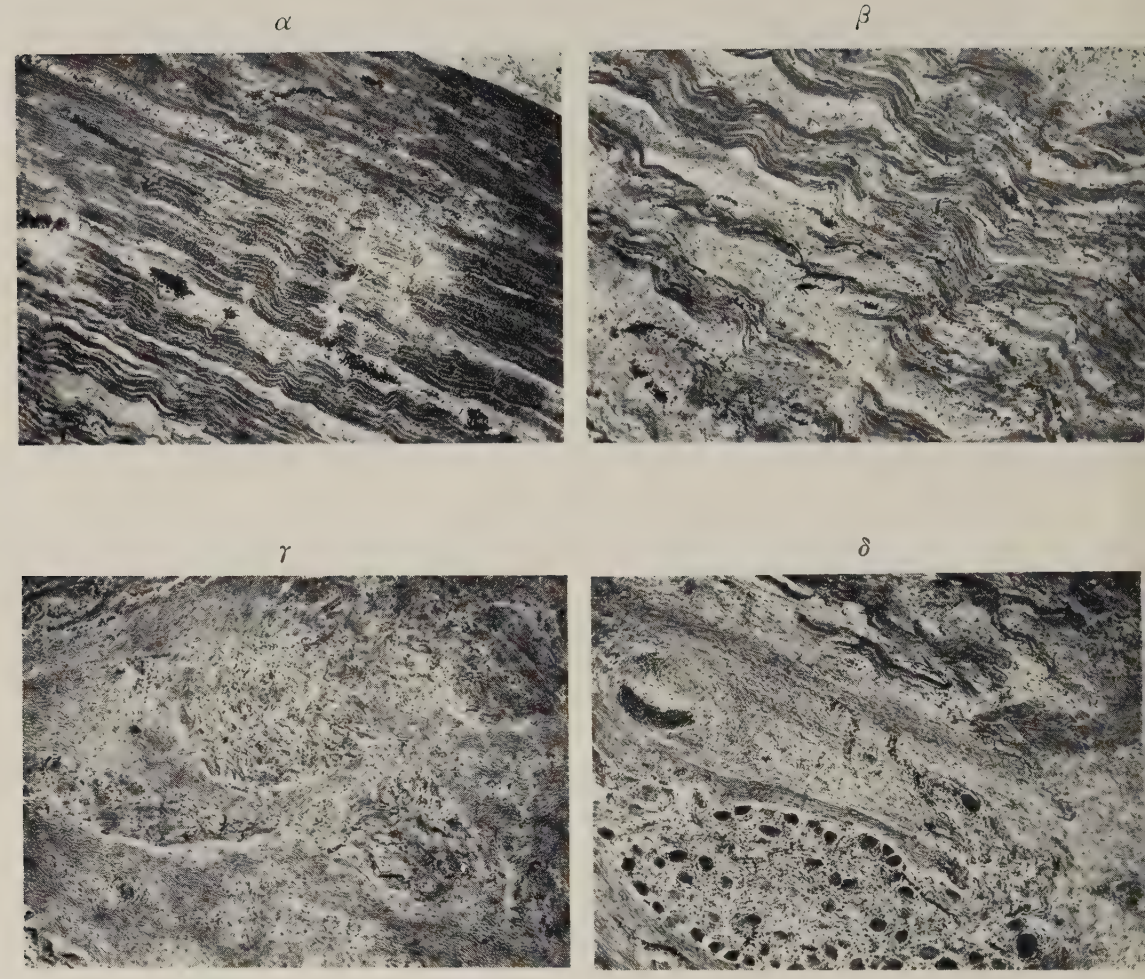

Fig. 6. Photographs taken from several places of fig. 5, magnified.

α: Superficial layer of the C-bundle. Note the relatively straight and parallel course of muscle fibre groups and pauvity of the connective tissue.

β: Deep layer of the C-bundle continuing directly into the *Tawara*'s node. Wavy course of muscle fibre groups and increase of the connective tissue.

γ: A portion of the *Tawara*'s node. Reticular muscle fibre groups between very rich connective tissue.

δ: At the bifurcation of the *His*' bundle. Swollen muscle fibres (upper right) and a group of ganglion cells (below) are seen.

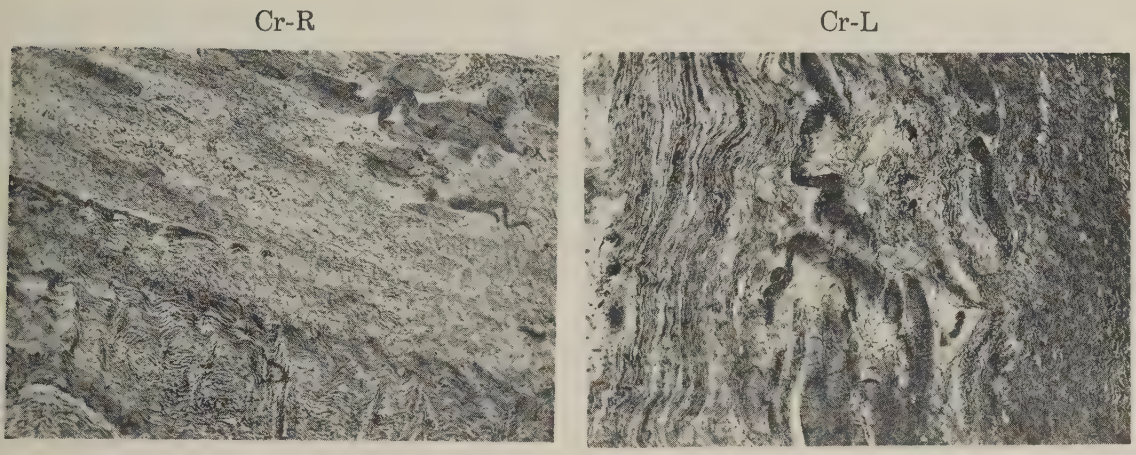

Fig. 6. Photographs taken from several places of fig. 5, magnified.

Cr-R: Right crus of the *His'* bundle, near the bifurcation. Swollen muscle fibres (upper) and a nerve bundle (left below, half hidden); between them very rich connective tissue.

Cr-L: Left crus of the *His'* bundle, near the bifurcation. Swollen muscle fibres (in the middle) and abundant collagenous fibres.

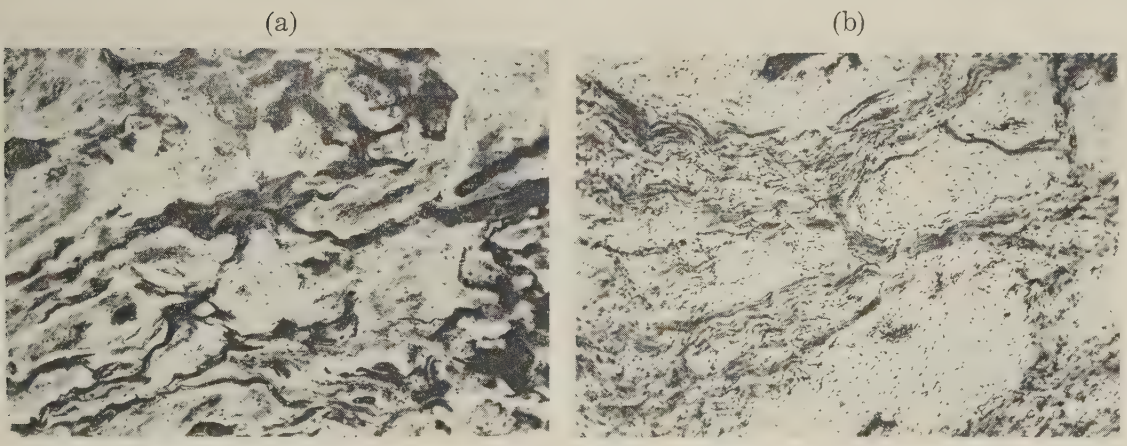

Fig. 7. The *Tawara*'s node of Berardius (case V), showing reticular arrangement of muscle fibres.

(a) Stained by hematoxylin-eosine.

(b) *Bielschowsky*'s method.

Some Remarks on the Pygmy Sperm Whale, *Kogia*

By

Munesato Yamada

(Received December 14, 1953)

Introduction

Prewar Japan has recorded at least eight cases[1] of the pygmy sperm whale, *Kogia* Gray. Dr. Teizo Ogawa (1936–37), professor of anatomy at the University of Tokyo and also a director of the Whales Research Institute has pushed our knowledge of this rather unusual whale so extensively forward, concluding a prospect that kogiids might most probably occur in two specific forms as *Kogia breviceps* (Blainville) and *K. simus* (Owen). Drs. Nagamichi Kuroda and Yaichiro Okada adopted his view in their list and catalogue (1938). Meanwhile in 1937, Dr. Kyosuke Hirasaka, then professor of zoology at the Imperial Taihoku University in Formosa published a paper, in which he described his own Ishigaki-Jima specimen and made simultaneously a wholesale discussion concerning the taxonomic problem of the genus. He related first seven of those specimens mentioned in the beginning (tab. 1).

Table 1. List of prewar kogiids from Japan.

No.	Institution	Sex	Locality	Date	Species after Ogawa	Recorded by
1.	Univ. Tokyo	?	?	?	*Brevic.*	Ogawa
2.	〃	?	Choshi	25–10–13	*Simus*	〃
3.	Kyushu Univ. Fukuoka	?	Awa Prov.	1915	*Brevic.*	〃
4.	Tokyo Med. Coll.	Male	Tsudanuma	30– 9–27	〃	Honda
6.	Former Taihoku Univ.	Female	Ryukyu	8– 3–35	〃	Hirasaka
5.	Tohoku Univ. Sendai	〃	Shiogama	16– 5–35	〃	Ogawa
7.	〃	〃	Linschoten	27– 7–36	*Simus*	〃
8.	〃	Male	Shiogama	7– 7–37	*Brevic.*	〃

Whereas, no record has been known ever since, but recently in 1951 through 1952 the author has secured the specimens of *Kogia* as many as twenty-three, of which eight individuals were examined in the fresh

[1] A skull (M1861) of unknown sex and locality of the National Science Museum in Tokyo is not included, and should be added. Also a skeleton described and figured by van Beneden and Gervais (1868–80) is from Japan, and at least one more (1887) has been known by historical record by Kunika Takenaka (see text).

state. The present paper is the republication that deals with six of them in 1951 from Taiji, Wakayama-Ken (Prefecture). This was partly published in the "Shizen" magazine (1952), but the more important descriptive part has remained unpublished because of its highly specialized interest that did not fit that popular magazine. This paper is naturally of preliminary nature since my acquisition is reasonably expected to grow further in the coming years and also because I have failed to make the thorough study of literatures this time.

Some Exterior Notes

Six kogiids now in question are listed in the following tables and illustrated by figs. 1–3 and 5 (a, b). When I picked up two skulls in the beginning of June 1951, I had certain reason to expect that either of them might be *K. simus* as mentioned by Ogawa. Again in July (22nd and 23rd) four more individuals were added, when I expected the same possibility more strongly. Ogawa's description of *K. simus* is based mainly on the skulls, so if any one of the present four were to be that species, its external characters should be recorded very carefully. It would be very convenient for this problematic comparison of two species since three were brought ashore at the same time by two boats on July 23rd. But my work was pretty difficult because they hurried to flense the whales while they were fresh enough for processing. The greatest failure of myself at the occasion owing to the hurrying up of examination was to have missed the total lengths of nos. 5 and 6, particularly important specimens in the present consideration. It was apparent that these two were important above all, if any considerable difference was searched for among the three, in their external characters. Both were male, still differed to a noticeable extent.

Four animals thus examined in fresh state are roughly, with exception of no. 6, similar in colour, namely dorsal dark gray and ventral ivory white. More or less pinkish or purplish blurs are sometimes seen in the ventral white region, but this seems reasonably to be a post-mortem change as cadaveric livor, as whalers say that this never happens immediately after catch.

But impression of no. 6 is different because purplish brown tinge is added all over, which is noticed particularly on the sides in the dorso-ventral transition zone throughout, from the snout to the trunk. There are distributed a large number of seal-like speck not larger than 1 cm. in length, 3–4 mm. in breadth, situated parallel to the body axis. Moreover, large and small fleckles are scattered among them, but they

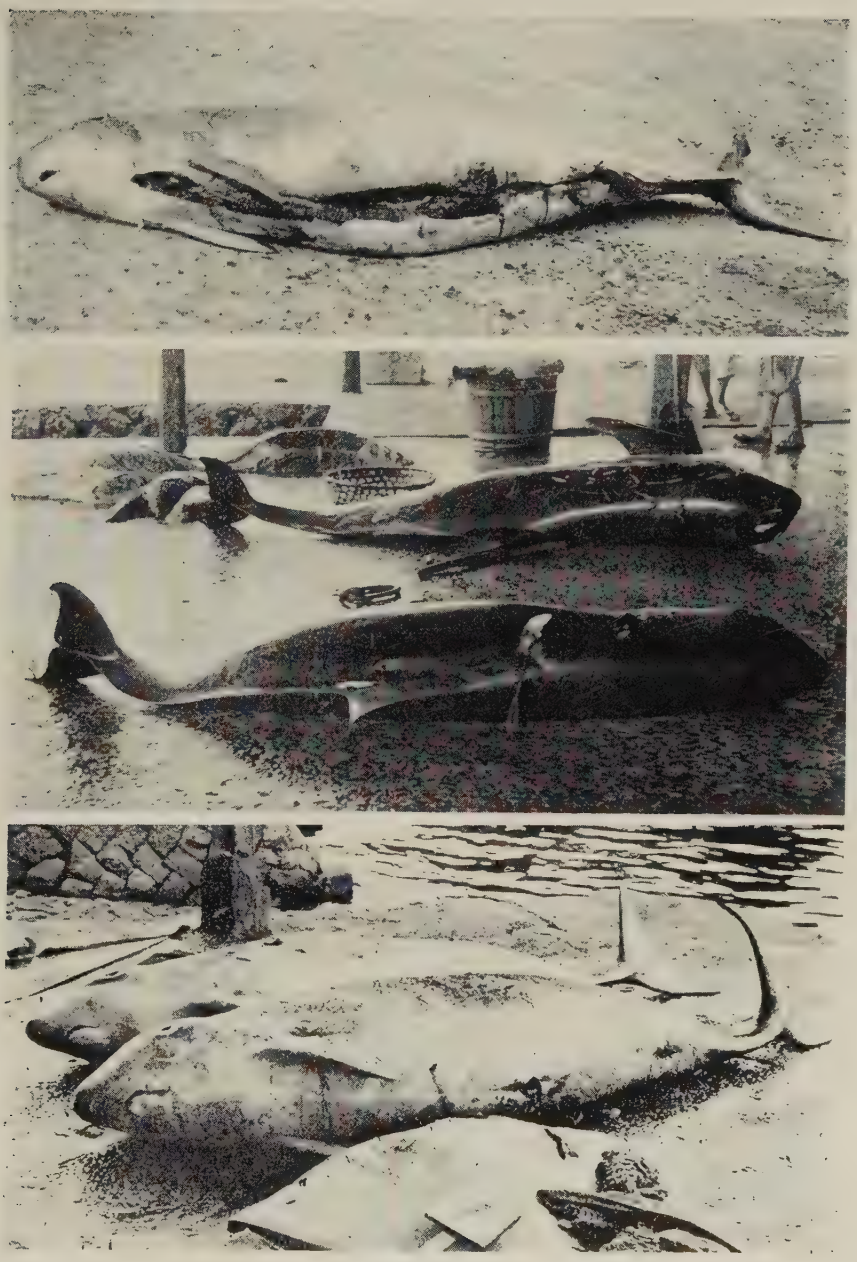

Fig. 1 (*top*). No. 3 female (22–7–51).
Fig. 2 (*middle*). No. 4 female (23–7–51). A Risso's dolphin in the background.
Fig. 3 (*bottom*). Nos. 5 and 6, both male (23–7–51).

are smaller and paler than those specks mentioned above. This animal also differs from the rest in distribution of the ventral light colour which ends about 20 cm. behind the anus, while in others, it expands further caudalward along the keel into the under side of the tail flukes. Hence in no. 6, under side of the caudal portion including tail flukes is darker in purplish dark brown, which is, however, somewhat paler than the dorsal black colour. The Noordwijk specimen from Holland reproduced in oil painting by Boschma (1951), the Grayland specimen reported by Scheffer and Slipp (1948), the Imperial Beach specimen of Hubbs (1951) as well as two of mine (nos. 21 and 22) examined at Taiji in 1952 correspond well with this manner of colour distribution. Very recently

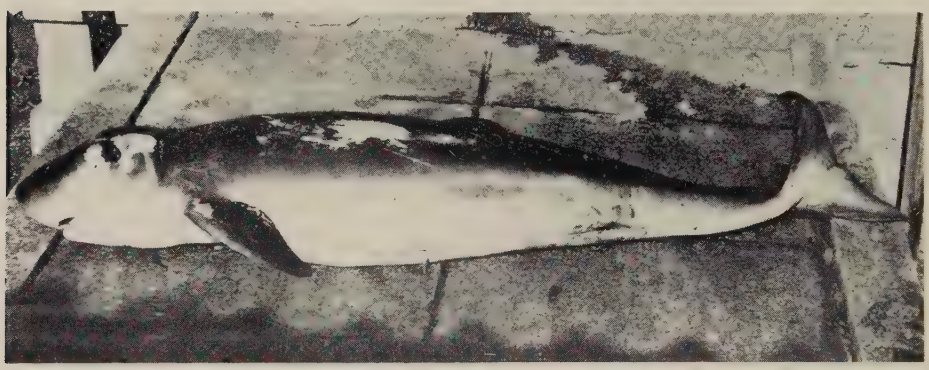

Fig. 4. No. 7 male from Tamashima (23-11-51).

Kuroda (1953), believer of Ogawa's opinion of *K. simus*, has published a monograph of Japanese mammals, in which he gives this type of colouration to *K. breviceps*, apparently based on the painting of Boschma, and to *K. simus* he gives another, not far differing one from my nos. 3–5. This colouration of *K. simus* differs from my nos. 3–5 in one major respect that the dorsal black is interrupted in sideward continuity into the lateral side of the flipper. This is obviously derived from Owen.

The exterior of *Kogia* has been given in figures and plates by Owen (1866), Kellogg (1940), Fraser (1948), Boschma (1951) and Kuroda (1953), as partly introduced above, but none of them reproduces the following pattern which seemingly characterizes the genus. This pattern is located behind the eye and in front of the flipper, and really related with the external ear hole. The pattern consists of two processes of the ventral white colour upward into the dorsal black region as shown in fig. 5 a and b. The rostral one ascends vertically toward the ear hole, but is toned more or less faintly according to individual animals. Meanwhile

another one is falciform, ascending in a broader arc which ends also pointing toward the ear hole from behind. To the consequence, a relatively large island of dorsal colour is left encompassed between the two markings. The posterior falciform marking begins closely in front of the flippers, where the dorsal black of the posterior border extends in a limbus-like hook into the ventral white, curving and tapering rostrally,

Table 2. External measurements (mm). All measurements are made in a straight line, but (2) and (3) are projected upon the body axis.

Specimen number Sex	No. 3 Female	No. 4 Female	No. 5 Male	No. 6 Male
1. Total length, from snout to notch of flukes	2180	2220	—	—
2. From snout to tip of lower jaw	105	75	100	110
3. From snout to center of blowhole	160	163	200	200
4. Length of blowhole	—	50	—	65
5. From snout to center of eye	240	225	245	250
6. From center of eye to ear hole	45	77	80	80
7. Lower jaw, from tip to corner of gape	75	93	90	105
8. From snout to tip of flipper	790	785	870	860
9. From notch of flukes to rear base of dorsal fin.	910	930	1140	1030
10. Dorsal fin, length at base	300	340	330	420
11. Height of dorsal fin	145	130	110	175
12. From notch of flukes to anus	650	685	820	820
13. From notch of flukes to center of vulva	685	725	—	—
14. From anus to center of vulva	40	—	685	680
15. Flipper, radial length	325	330	370	375
16. Flipper, ulnar length	265	240	240	275
17. Greatest width of flipper	125	120	130	150
18. Left fluke, from tip to notch	—	285	—	395
19. Right fluke, from tip to notch	310	275	330	—
20. Tail flukes, distance between tips	560	535	—	—
21. Breadth of fluke at base	—	—	200	220
22. Depth of body at anus	—	375	400	440
23. Length of head, from snout to condyle	—	—	360	400

thus giving a strong accentuating impression to the pattern. In regard to this pattern, no. 7 male from Tamashima (Okayama-Ken) agrees well (fig. 4), to say nothing of the later additions from Taiji (nos. 21–23). Also Ogawa's specimen (no. 8 of tab. 1) from Shiogama (Miyagi-Ken) seems similarly patterned though indicated dimly in the photograph. No other record has seemingly described the pattern before, hence I thought either that this has been overlooked or that this might be a hitherto unnoticed character of the Japanese kogiids. But recently Hubbs (1951) mentioned a similar pattern which, thanks to the alive condition of

his Imperial Beach specimen, was well illustrated to consist of a "bracket-like mark", a falciform marking similar to my cases as reproduced in fig. 5 c for comparison. It is important in this connection that Hubbs introduced an information of G. L. Camp concerning a female together with a fetus of it stranded near New York some years before him, that they showed also the similar pattern which could be expected to be a generic character of *Kogia*. Without doubt I agree with and admire his opinion, but should point out that kogiids from the Japanese waters differ to a certain extent from those from the American coasts both Pacific and Atlantic, as is obvious from the foregoing descriptions and fig. 5.

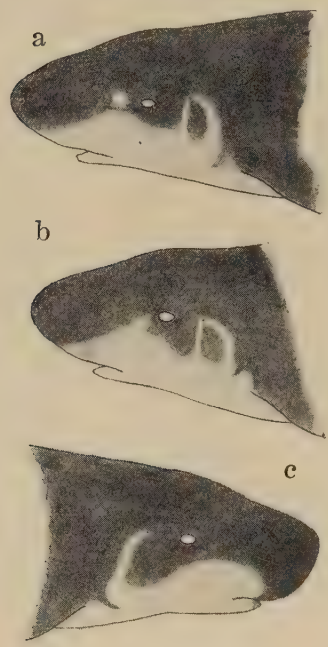

Fig. 5. Head of *Kogia* showing various pattern types. *Top-* no. 5, *middle-* no. 6, *bottom-* Imperial Beach specimen (reproduction after Hubbs, 1951).

Another slight difference pertaining to the colour pattern of my cases from the Imperial Beach specimen is the stronger upward extension of the ventral white closely in front of the eye, and an extreme case is shown in no. 5, where the extended white is torn up and separated in a round patch (fig. 5 a).

Problems in the Skeleton

The separation of *K. simus* from *K. breviceps* suggested by Ogawa is based on the differences particulary of the skull besides the dentition, which are summarized as follows:

1. The rostrum is more sharply pointed at its extremity in *breviceps*, while in *simus* it is less pointed and rather round.

2. The large fossa bordered by the maxillaries on the facial region of the skull is narrower and deeper in *breviceps* than *simus*. Consequently the bordering wall of the fossa is steep in the former and in the latter lower, sloping more gently.

3. In *breviceps*, the maxillaries are seen broader on the sides, and the suture line between this bone and the malars is rather irregular, while in *simus* beautifully marked by an S-shape.

4. The antorbital process of the malars extends shorter in *breviceps* than *simus*.

5. The palatal bones of *breviceps* present wider on the cranial basis, but in *simus* they show very limited appearance between the maxillaries and pterygoids.

6. The roof of the orbit curves more gently in *breviceps*.

7. The upper part of the frontals of *simus* is interposed between the maxillaries and the occipital further than *breviceps*.

8. The breadth of the temporal fossa far exceeds the depth in *breviceps*, while these do not differ so much in *simus*.

9. The squamous part of the occipital swells out spherically above the occipital condyles in *breviceps*, while in *simus* it rather caves in.

10. In *breviceps*, the mandibular symphysis is longer and the mandibular rami gradually diverge sideways, whereas in *simus* this divergence is abrupt.

11. Other than the skull differences, the spinous process of the cervical vertebrae, fused into a single bone, is peculiarly much longer in *breviceps* than *simus*.

Through a close examination keeping these differences noticed by Ogawa in mind, the skulls nos. 2 and 6 come especially to the fore out of my specimens with more characters of *K. simus* apparent, and besides, it is noticed at the same time that no. 5 often shows a tendency to resemble this species. Among the above mentioned comparisons, the articles 2nd, 4th, 6th and 7th actively distinguish the groups, but even the rest does not make special oppositions with exception of 8th which seems alone really opposite.

The measurements of the skulls are given by tab. 3, and indices calculated with certain prospects are listed in tab. 4, most of which, however, does not fully satisfy me. Difference of the malar index (*5*) is not new because it may be expected through the 4th article of Ogawa's comparison, but the grouping by the length-breadth index (*4*) seems to bring some significance. From the measurements in the previous records the indices are available for the present consideration as: 84.8 (Wall), 85.0 (Le Danois, Hirasaka, Ogawa), 88.2, 89.8 (v. Schulte) and 90.4 (Owen). It seems of particular significance here to note that the greatest index is derived from Owen's specimen, the type of *K. simus*. If the species has been properly established and the greater length-breadth index of nineties be of it, nos. 2 and 6 might be reasonably identified to be that species. Regrettable matter in this connection is that the index is not obtainable of the two skulls of Ogawa's *K. simus*. I expected above all much in vain from the indices related to the occipital bone (*6–9*) because I thought that its squamous part (supraoccipital)

Table 3. Skull measurements (mm). When certain artifacts are added, measurements are marked *, for instance, separated mandibles brought together after maceration.

Specimen number	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
1. Total (condylo-basal) length	276	302	(Skull is preserved for soft part anatomy, hence no measurements)	271	284	297
2. Length of rostrum, from tip to fundus of antorbital notch, left	132	164		140	165	160
—, right	126	158		136	149	149
3. Breadth of rostrum at base	129	139		128	136	140
4. Ditto at middle of rostrum	92	115		79	99	86
5. Ditto at extremity	39	31		23	32	26
6. Greatest breadth of premaxillae	71	—		76	85	84
7. Breadth of premaxillae at middle of rostrum	44	63		39	54	41
8. Distance between tips of premaxillae	15	14		10	14	15
9. Facial length, from tip of rostrum to rear of maxillae	228	258		235	250	265
10. Facial breadth, greatest breadth of maxillar (facial) fossa	165	180		169	182	196
11. From tip of rostrum to rear margin of superior nares, left	147	170		157	168	174
—, right	141	157		146	154	166
12. From tip of rostrum to rear of pterygoids (median)	149	182		151	163	175
13. Breadth between orbits	230	253		218	240	259
14. Breadth between temporal fossae	169	199		158	164	213
15. Breadth between postorbital processes, Greatest breadth	250	279		234	256	277
16. Width of occipital foramen	35	38		34	30	33
17. Distance between lateral margins of occipital condyles	75	86		72	76	82
18. Greatest breadth of occipital	208	235		210	220	236
19. Greatest height of occipital	139	152		145	145	152
20. Height of supraoccipital	95	106		103	100	105
21. Length of mandible	234	256	227	224*	253	255
22. Length of symphysis	34	46	39	30*	45	45
23. Width of proximal end of symphysis	25	42	27	24	30	38
24. Length of alveolar region, left	94	103	104	102	108	106
—, right	93	97	105	100	106	107
25. Height of coronoid	70	77	73	61	67	65
26. Breadth between mandibular condyles	201*	252	220*	198*	229*	248

might well be correlated with the spinous process of the cervical vertebrae, which differs so remarkably between two species according to Ogawa, and also because the process of my no. 6 really extends so noticeably (fig. 8).

Nos. 2 and 6 show some other common characteristics, among which it seems important that the mid-facial crest is broader in comparison with no. 5, and no saying far broader than other individuals. Another

Table 4. Indices of skull.
Figures, italic type in parentheses, indicate the articles of tab. 3.

Specimen number	No. 1	No. 2	No. 4	No. 5	No. 6
1. Facial length-breadth index, (*10*)/(*9*)×100	72.4	69.8	71.9	72.8	74.0
2. Facial length index, (*9*)/(*1*)×100	82.5	85.4	86.7	88.0	89.3
3. Rostrum index, (*2*)/(*1*)×100	47.8	54.3	51.7	58.1	53.9
4. Length-breadth index, (*15*)/(*1*)×100	90.6	92.4	86.4	90.1	93.3
5. Malar index	26.1	33.1	24.9	30.6	33.5
6. Occipital index, (*19*)/(*1*)×100	50.4	50.4	53.5	51.0	51.2
7. Facial-occipital index, (*19*)/(*9*)×100	60.0	58.9	61.7	58.0	57.5
8. Squamous occipital index, (*20*)/(*19*)×100	68.3	69.8	71.0	69.0	69.1
9. Squamous height index, (*20*)/(*1*)×100	34.4	35.1	38.0	35.2	35.4

interesting peculiarity common to these two is the morphology of the occipital condyles: In nos. 2 and 6 the lower extremities of condyles are situated very close and the articulation surface itself is rough in a peculiar way, while in other skulls the spheric smooth condyles stay distinctly apart from each other (fig. 6). These two types of condyle are extremes, and there is no intermediate between them. The Tsuda-numa specimen alone, one of the most typical *K. breviceps* from Japan and also male, seems to keep the close condyles like nos. 2 and 6, according to a photograph of Ogawa. The relation between type of condyles and either species appears, therefore, indefinite.

The mandible of typical *K. breviceps* mentioned by Ogawa is that of no. 3 alone; nos. 2 and 6 fully represent once again the characters of *K. simus*; and the rest the intermediate form which rather resembles the latter species (fig.7). With this general tendency of shorter symphysis the small dental formula may have some intimate relation. None of my specimens has more than 21 teeth in the lower jaws, in spite that the dentition of *K. breviceps* is said to be usually 12–14 pairs (tab. 5). In this respect, nos. 2 and 6 may be identified as *K. simus*

Table 5. Dental formulae.
Absence of upper teeth in no. 1 is not certainly examined, they may be possibly lost. The side is unknown of the upper tooth in no. 2.

No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
0: 0	1	1: 0	1: 1	2: 2	0: 1
11:10	8: 9	9:10	9:10	10:10	9: 9

and the rest to interlink this and the typical dentition of *K. breviceps*. One more note seems necessary concerning the upper teeth which are also said to characterize *K. simus* and really very popular in my cases.

This may be judged literally to agree *K. simus* on one hand, but on the other that they exist in reality more than it has been thought before, because they are easily stripped off or decayed away with the gum during the procedures prior to the examination by cetologists or exhibition at museums.

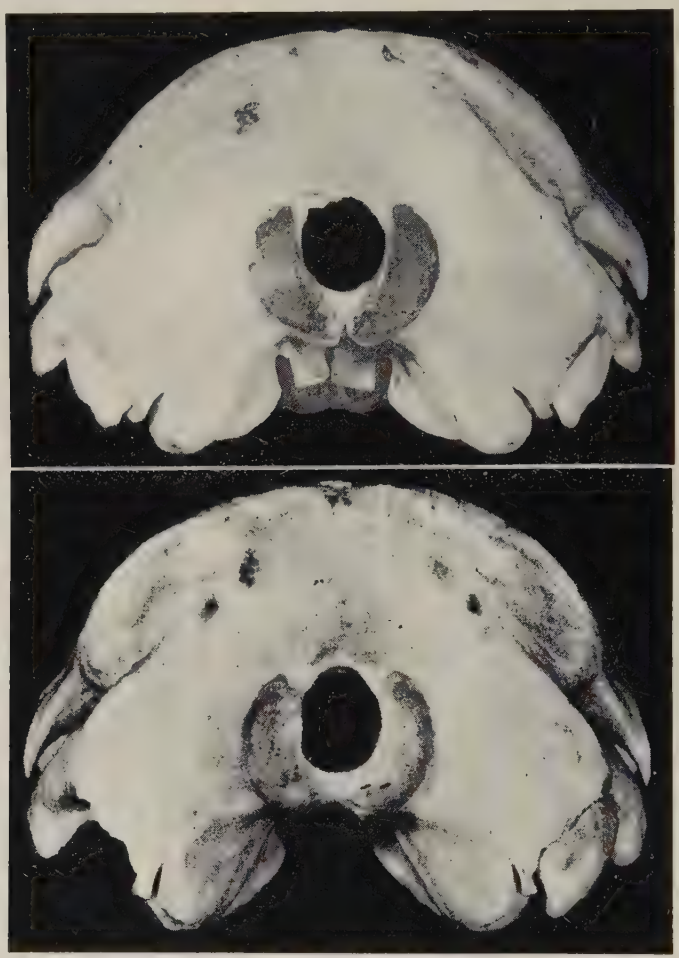

Fig. 6. Rear view of skull. *Upper-* no. 2, *lower-* no. 5. Note occipital condyles distinctly different.

The vertebral formula is included in tab. 6, in which nos. 3–5 are noticed to be greater than the previous records. The total number is 50–55 after Le Danois (1911), and 56 of Ogawa's female (no. 6 of tab. 1) exceeds this range by one segment. But my nos. 3–5 are still more. Whereas no. 6 stays in the range of Le Danois with less segments, and

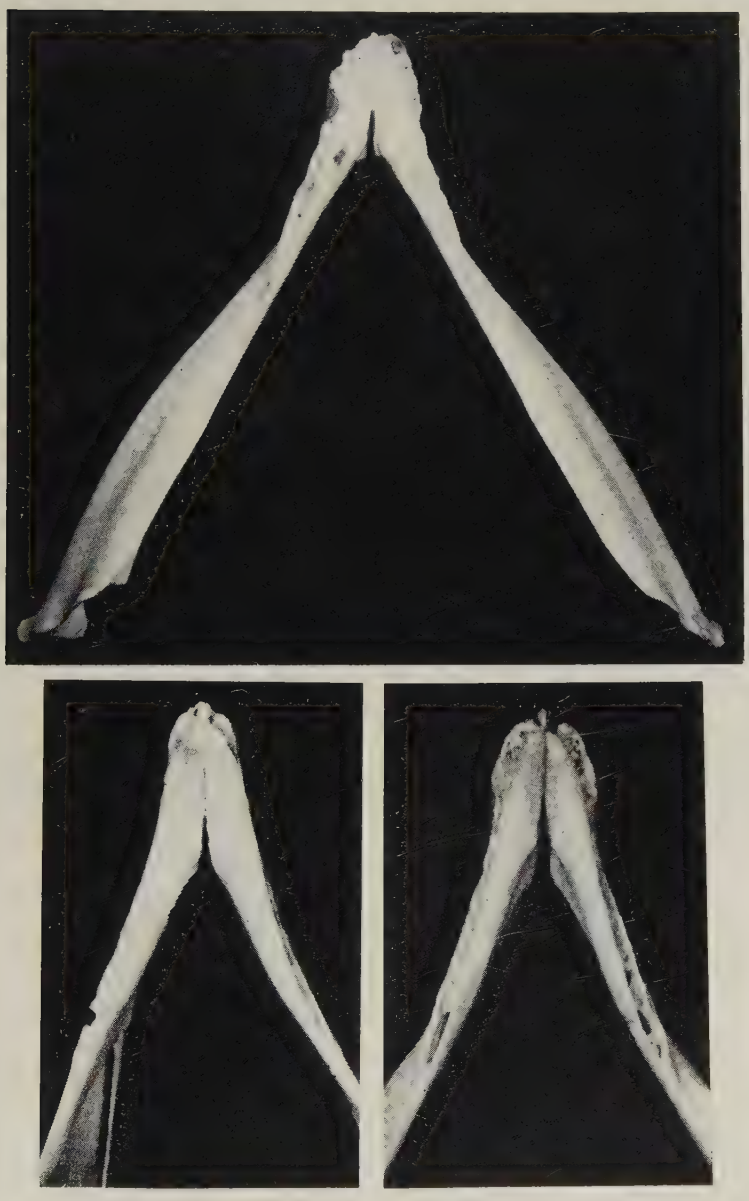

Fig. 7. Mandible. *Top-* no. 2, *bottom* nos- 3 (*left*) and 5 (*right*). Nos. 3, 5 and 2 show a serial difference of symphyseal region in the given order. No. 2 alone is perfectly ankylosed.

thus shows the tendency of *K. simus* noticed by Beddard (1900–23) in comparison with the rest specimens, though his actual numbers are less than my cases, viz. 54 for *breviceps*, 50 for *simus*. The discrepancy in

dorsal as well as lumbar vertebrae must here be allowed, though the distribution in these regions has been said to distinguish the animal rather than the total number. The discrepancy is naturally related to the less ribs of no. 6.

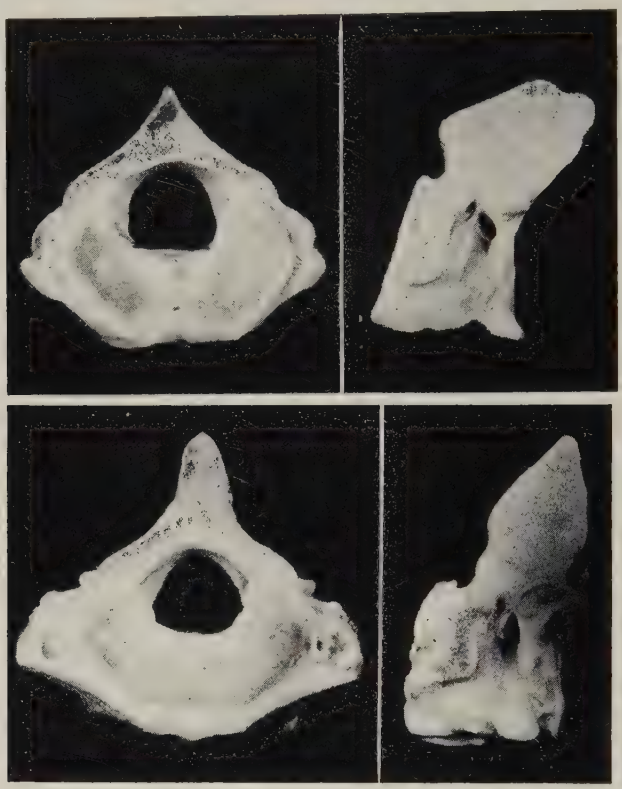

Fig. 8. Cervical vertebrae, cranial and side views. *Upper-* no. 5, *lower-* no. 6. Note the different length of spinous process.

However, what interests me most about the vertebrae is the morphology rather than the formular number, namely the spinous process differs in its relative dimension also outside the cervical region, concerning which the difference has been recorded by Ogawa as quoted in the beginning and illustrated by fig. 8 of my nos. 5 and 6. The indices are tabled in tab. 7 which indicates that the spinous process of no. 6 is obviously longer than no. 3. Concerning the first caudal, the indices differ also in the same way, and no. 5 interlinks nos. 3 and 6 (figs. 9, 10). The spinous process that varies thus in length is naturally expected to give the appearance of animals certain difference as a result, which however, I did not notice when some were searched for between nos.

Table 6. Bone numbers.

Specimen number	No. 3	No. 4	No. 5	No. 6
Vertebrae, total	57	57	57	54
Cervical	7	7	7	7
Dorsal	13	13	13	12
Lumbar	12	11	10	11
Caudal	25	26	27	24
Chevron	14	16	18	16
Costal pair	13	13	13	12
Pair with tuberculum	8	8	8	8

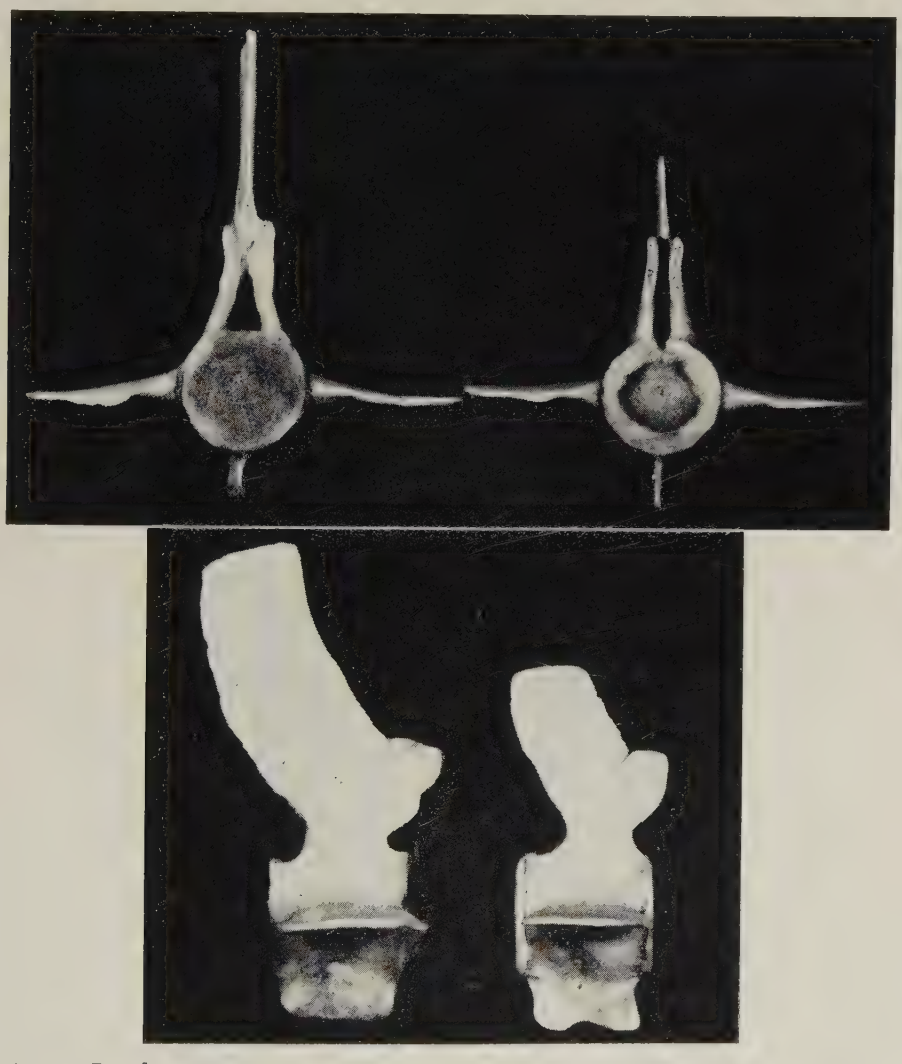

Fig. 9. Lumbar vertebra, cranial and side views. *Left-* no. 6 fifth, *right-* no. 5 eighth, hence difference in length of spinous process is exaggerated.

Table 7. Vertebral indices.

$$\frac{(\textit{Depth of corpus})}{(\textit{Entire depth including spinous process})} \times 100$$

Sp. no.	No. 3	No. 5	No. 6
D 7	24.6	—	22.2
D 8	24.2	—	22.7
L 5	29.1	—	28.1
Ca 1	43.4	42.4	41.2

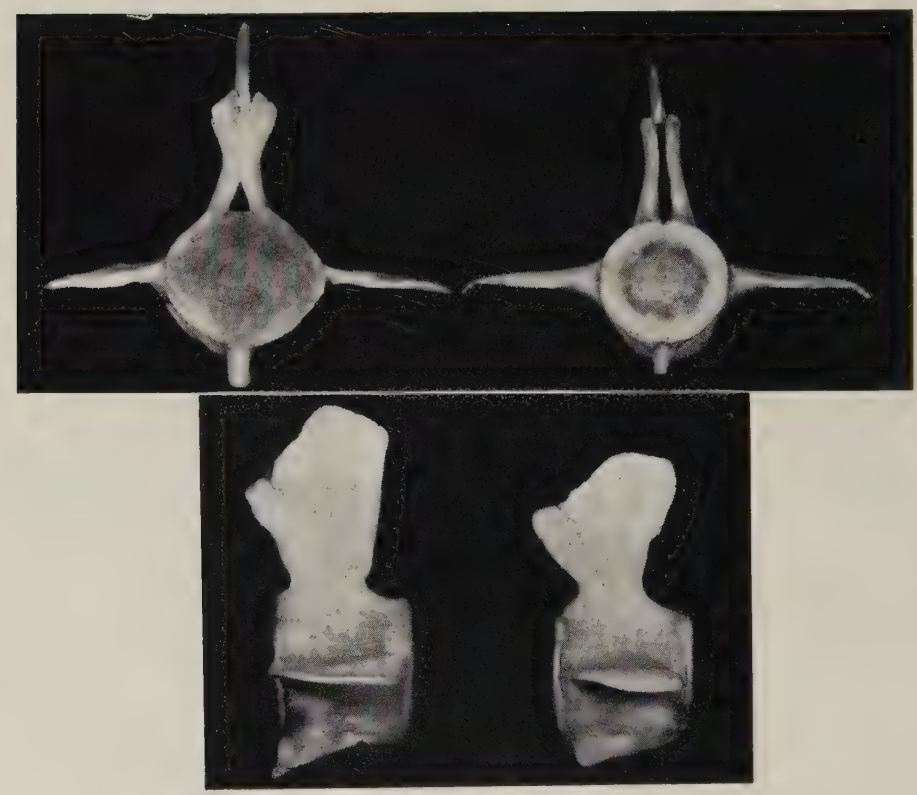

Fig. 10. First caudal vertebra, cranial and side views. *Left-* no. 6, *right-* no. 5.

5 and 6 at beach. Therefore, it seems very hard to mark the difference according to the exterior, but let us once again go back and compare the two in fig. 11, then the difference seems to be appreciated in the depth of body as compared in tab. 2 (*22*), yet this seems not so distinct as to make us decisive.

Another interesting comparison should be mentioned finally. It is

the sternum, of which the jugular incisure is peculiarly far deeper in no. 6 than all others (fig. 12). Here is too no intermediate, though slight differences are present in the group of no. 5. In the meantime, I missed the important knowledge of the digital formula because of failure in the course of preparation.

Fig. 11. Nos. 5 (*left*) and 6, (*right*), front view for better comparison of body depth.

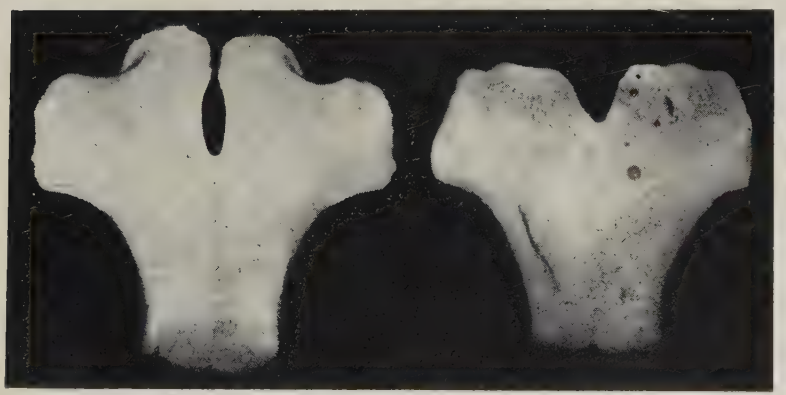

Fig. 12. Sternum. *Left-* no. 6, *right-* no. 5. Note jugular incisure.

Since both nos. 5 and 6 were brought ashore by one boat "Takara Maru", I liked to know what was known at sea, especially if they belonged to the same school or were separated. Gunner Mioji Kishi gave

me a detailed information, through which it was testified that no. 5 was with no. 4 in a school of six or seven whales, and no. 6 in another of two to three. This may somewhat favour on one hand the opinion to recognize *K. simus* and seems on the other to be a new knowledge of the habits of kogiids.

I do not think that the above results perfectly distinguish *K. simus* from *K. breviceps*, though two rather distinct types apparently do exist. If these types were connected continuously by certain link, I could agree in the recent opinion since Hector (1877) to unify all species of *Kogia* into one. Nevertheless, the intermediate form between two types like no. 6 and others has not been procured until now in spite of my eager wish to have some. I must mention at the end one more discussion concerning the lasting question of the size of *Kogia* in relation with the systematic problem.

Le Danois (1911) and v. Schulte (1917) pointed out the immaturity of the type specimen of Owen, which seemingly gave rise to the recent and leading opinion of unifiers. Hirasaka (1937) thought also likewise and proposed 30 cm. long skull as the demarcation, saying that the larger animals than this size represent more characters of *K. breviceps* and the lesser ones *K. simus*. However, most of my specimens are not larger than 30 cm. in the length of skull and no. 2 alone slightly exceeds this demarcation. Moreover, among my specimens, nos. 2 and 6, which are regarded more strongly as *K. simus* after Ogawa, belong to the larger group, obviously full grown judging from the ossification examined in the entire skeleton. Whereas, the rest belong to the lesser group which shows more characters of *K. breviceps*, still they are never immature. No. 5 is above all perfectly ossified and even the smallest no. 4 was lactating. To the remark of pregnancy a special importance has been attached by Ogawa as the most reliable sign of maturity, and either of nos. 1 and 2 was certainly pregnant, which I suppose to be no. 1. I am now of opinion that kogiids vary considerably in size, and that sexual maturity should be carefully considered not to confuse with the grown-up animals of perfect ossification. And I, apart from the systematic problem whether or not *K. simus* be separated, oppose to the opinion that the younger animals with the skull under 30 cm. are gradually converted from the initial resemblance to *K. simus* into the general type of *K. breviceps* as they grow up. This opposition has been raised already by Ogawa himself (1939), with whom I agree.

Another opinion of myself is this, that the lasting dispute has been caused because no addition of typical *K. simus* has been known after

Owen, and I wonder from time to time that the whole discussions might be utterly inappropriate and we should look forward to the future specimens. In 1952, I secured a female porpoise of *Feresa intermedia* which seems to have disappeared long ago from the current interest of cetologists and I myself too have never dreamed of such an unusual acquisition. Who can deny the future possibility of Owen's *K. simus* to appear before us?

Some Miscellaneous Notes

Van Beneden and Gervais (1868–80) introduced the name "*Uki-Kujira*" to be used by the Japanese of *Kogia*, of which they were informed of their *Kogia du Japon* labelled by the sender, the Japanese Government at the time. But nevertheless, its source has remained unknown for long, and the current name "*Komakko*" has been given to it, as the English name lesser or pygmy sperm whale means it, after the whale has been added to the cetacean fauna of Japan by the Japanese zoologists first in 1927. I have been afraid deeply in this connection, that this name would bring some confusion sometime and somewhere, since the name belongs to the routine vocabulary of our whalers who mean by it the small-sized sperm whale under the limitation of the international regulation instead of *Kogia*. And really the matter seems serious because the Japanese are the famous whaling nation, to whom sperm whales have a top importance and also because kogiids too are practically included in the catch of smaller cetaceans at Taiji, and Shiogama (nos. 6, 8 in tab. 1) to say the least. The catch of kogiids at Shiogama is rather limited, but at Taiji it is annually constant, around ten out of several hundreds of blackfish, dolphins and porpoises. The records of kogiids have been steadily increased the world over but they are mostly stranded cases and accordingly infrequent. The constant catch at Taiji is, therefore, quite exceptional on earth, and kogiids have been called "*Tsunabi*" among whalers there[1]. The appearance of kogiids off Taiji is confined to the trying summer season probably due to their migrating habit. All this was unmasked in 1951 and made known first to the public by myself, since then I have made a proposition of this vivid name "*Tsunabi*" to substitute the confusing "*Komakko*". Its origin is, however, not known, but after the opinion of Mr. Chuhei Mizutani, it is reasonably supposed that they have named so after a kind of firework *tsunabi* which is propelled in the air along a line. The strange habit

1) Prof. Ogawa (1936–37) introduced another name "*Zaru-Kaburi*", possibly translated as "with basket on", from Shiogama after a witness' saying of no. 6 in tab. 1.

of kogiids at sea, jointly stressed by the veteran whalers there, must have made whalers of old days associate with this type of firework, their favourite boyhood hobby, Mizutani suggested. The strange habit of kogiids goes like this, that they are very often found basking at the surface of sea and stay so innocent of the approach of whalers that harpooning is not very difficult. Then they are frightened at the sudden attack and submerge to the depths, when, regardless of success or failure, they leave evacuations which are easily mistaken by the beginners for bleeding. Some persons call kogiids for this habit as the skunk of the sea. And Mizutani concluded that this evacuating habit and instant disappearance suggested *tsunabi*, the rocketting firework. The evacuation at time of shock in kogiids interested me very much because it is also the case with the closely allied true sperm whale, which I have observed myself, and of which also some leading gunners of my acquaintance testified to my enquiry. It is especially important that this name lives with whalers, presumably only whalers in the world who prey upon kogiids at present as well as in history. Dr. Remington Kellogg of the U. S. National Museum in Washington wrote me some time ago that so many acquisition of kogiids suggested their more frequent occurrence off the coast of Japan than elsewhere. But I necessarily add some words concerning this that it may be a mere outward phenomenon thanks to the local but traditional whaling at Taiji.

The basking nature of kogiids as included in the just mentioned story agrees well with the record of Drinker together with the slow-moving, lethargic nature mentioned by Allen (1941). Since the ancient name "*Uki-Kujira*" of unknown source and locality means "floating whale" which, without doubt, names our kogiids so properly and wonderfully that I had imagined that the name was originated somewhere where the whaling was as prosperous as Taiji for some time in history and they must have called our kogiids so after very close and careful observations at sea. Soon later this imagination has been fortunately proved right when I read a manuscript by Kunika Takenaka, entitled "Bonan Hogei-Shi" (Whaling in Southern Awa) and written in 1887. I found "*Uki-Kujira*" in the writing, together with Pacific bottle-nosed whale (*Berardius*), Cuvier's beaked whale (*Ziphius*) and blackfish (*Globicephalus*) to be hunted by ancient whalers in the province of Awa. It was fortunate that the author himself experienced a case on June 12th, 1887, of which he gave a painting (fig. 13), and through this and descriptions my imagination has been proved perfectly right. How many kogiids were caught there, I do not know. But pretty often

procurements from that province may be definitely expected as indicated by tab. 1 (nos. 2, 3, and presumably inclusive of no. 1 without locality). Also *Kogia du Japon* of van Beneden and Gervais seems in consequence most probably to be recorded from the province of Awa. With the

Fig. 13. "Uki-Kujira" by Kunika Takenaka. Upper teeth are obviously figured by careless mistake, judging from the seemingly correct description, 16 in lower jaws.

decline of ancient whaling there, which apparently happened in relatively recent years, "*Uki-Kujira*" appears to have been fated absolutely forgotten, even among the present *Berardius* whalers there, and barely some two or three skulls have been kept unnoticed until the recent renaisscence of Japanese cetology, to which Prof. Ogawa has made so great contributions.

Acknowledgements

Mr. Chuhei Mizutani has generously offered his kindness for the necessary examinations I needed. Many assistances were also received during my stay at Taiji through Messrs. Fukujiro Yamashita, gunner for the Antarctic whaling; Taro Shoji, president of the fishers' association there; Teruichi Shiozaki, Yasomatsu Seko, Mioji Kishi, fisher

and gunners, and many others. Drs. Teizo Ogawa and Ryoji Ura have encouraged my work very much, to both of them and to my father Dr. Manabu Yamada I owed much in finance. Informations have been given timely concerning the writing of Takenaka through Mr. Asakichi Izukawa and Dr. Yukichi Habara. Dr. Remington Kellogg kindly suggested me of Allen's paper, of which Miss Barbara Lawrence sent me a copy. To all of them I express my deep appreciation.

Summary

Six specimens of *Kogia*, Gray in 1951 from Taiji, Wakayama-Ken, Japan, are described in relation to the lasting systematic question, and summarized as follows, but they are just preliminarily mentioned.

1) External characters of nos. 3–6 mark off no. 6 from others.

2) Somewhat complicated pattern of the dorsal gray and ventral white is newly noticed around the eye and ear hole, to which the Imperial Beach specimen of Hubbs alone shows certain resemblance.

3) Skulls are divided into two groups, nos. 2 and 6 and others. The former are larger and show more characters of *K. simus* persisted by Ogawa. Some common peculiarities in nos. 2 and 6 are described.

4) Mandibles as well as dental formulae show general resemblances to *K. simus*, and the upper teeth are really very popular.

5) Skeleton other than the skull also distinguishes no. 6, in which the vertebral spines are remarkably longer and the jugular incisure of sternum is quite different. No intermediate is learned to bring continuity.

6) Two groups thus marked result a strong opposition against the dominant opinion of recent time that the younger animals of initial resemblance with *K. simus* turn into the general type of *K. breviceps* as they grow.

7) Some habits of kogiids are introduced in connection with the forgotten name "*Uki-Kujira*" and proposal of vivid name "*Tsunabi*" to substitute the current "*Komakko*" for fear of confusion.

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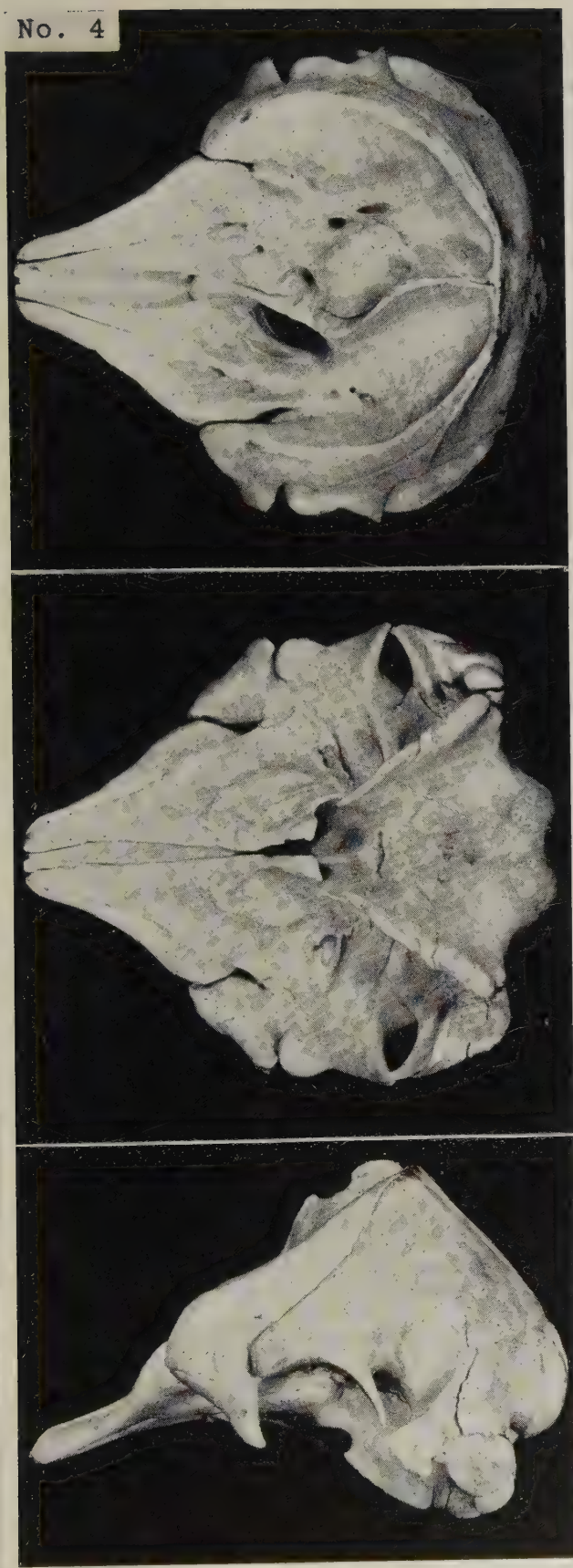
Explanation to Plate.

Dorsal, ventral and side views (from top to bottom of each column) of skulls, nos. 1, 2 and 4–6. The tympanic bulla or the mastoid process of ear bone is often dislocated.

No. 1

No. 2

No. 4



No. 5

No. 6

An Account of a rare Porpoise, *Feresa* Gray from Japan

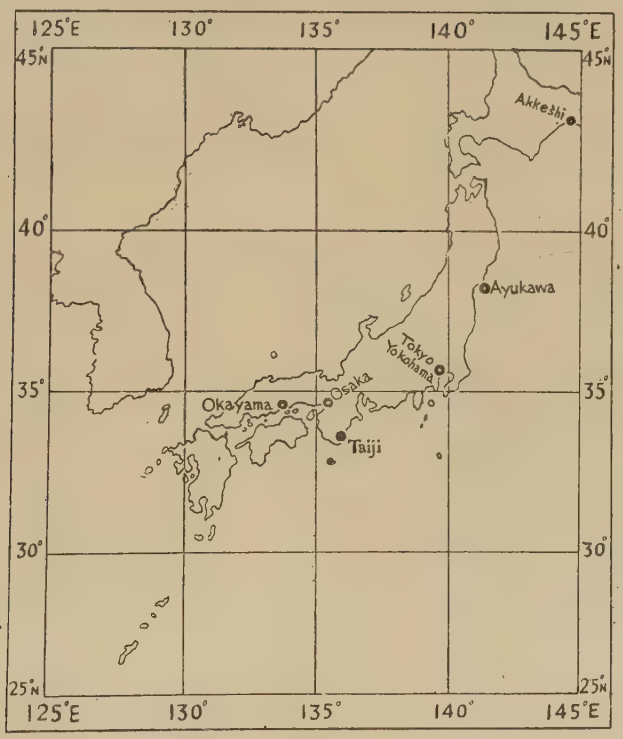
By

MUNESATO YAMADA

(Received February 15, 1954)

Introduction

In August of 1952 I had a six-day field work at Taiji, Wakayama-Ken (Prefecture), Japan. Taiji has long been noted by the cetologists of this country, and I myself have also been intensely interested in the cetacean fauna of this whaling town of long tradition and history (map). During the stay, three pygmy sperm whales (*Kogia*) came to my study,



and besides, more bone specimens of not less than ten kogiids were partly secured (Yamada, 1954, p. 37). Being contented with the fruitful acquisition of thirteen kogiids, I gave an end to that visit on August 21st and started in the following morning for a two-day trip in the

near-by mountainous regions in order to collect snails for my father's study. And it was when I was back again at Taiji in the evening of 23rd that I heard of the capture of a strange and unusual porpoise in that afternoon by a blackfish-boat (*Gondo-Bune*, so they say) "Hama Maru". This animal was later identified as *Feresa intermedia* Gray, which is here reported.

But to my great regret, the animal was instantly flensed before my return there, so I could not examine it while it was fresh. Emphasis was laid, however, on its very rare occurrence, and nobody told its provincial name nor any record of previous capture but one, who said that the same species of porpoise was caught there once in his memory about ten years before. Since the porpoise is not included in the regular cetacean fauna of Taiji, the animal was recorded and processed as the Risso's dolphin, *Grampus griseus* (Cuvier) according to the dominant opinion of the fishers. I had to be satisfied naturally with the acquisition of the skeleton reserved for my study by the courtesy of the Mizutanis who bought the porpoise, but some parts as the hyoid and pelvic bones were missing. According to the gunner who killed the animal, it was solitary at sea.

Shortly after the event, I had a talk with Prof. Dr. Teizo Ogawa of the University of Tokyo, when he suggested me of the possibility that the porpoise in question might eventually be of *Feresa*. The genus was established by J. E. Gray in 1871 and has been known by the two skull specimens at the British Museum (Natural History). The specimen 362a is the type of *F. intermedia* Gray and the other 1672a *F. attenuata* Gray. As I became strongly convinced of this prospect after closer examination of the present skull, especially measurements of it, a question naturally arose if any additions of *Feresa* have been made before now, and I liked to know them if any. I acknowledge in this regard the personal writings of Drs. F. C. Fraser (Brit. Mus.) and Remington Kellogg (U. S. Nat. Mus.) who kindly informed me that no addition had been known after the two type skulls just mentioned. Dr. Fraser later sent me complete photographs of these specimens, which assured me perfectly of the identification. No record of *Feresa* has been known from Japan, and my present account is, in the consequence, the third and the most complete *Feresa* in cetology. This is the reason why I give very detailed measurements in this paper. To the kind backings of the named gentlemen; Prof. Dr. Ryoji Ura of Okayama, director; and to my father Dr. Manabu Yamada whom I owe much in finance, I express my best thanks and sincere compliments.

Notes on the Exterior
(figs. 1–4)

Because of the flensed condition of the present Taiji specimen, only a bit of knowledge was learned about its external characters as well as dimensions. But painstaking examination of the pieces of blubber as well as the skeleton and teeth indicates the animal to be female and full-grown, apparently aged (cf. p. 71). Its total length measures about 235 cm. from the tip of rostrum to the notch of tail flukes by putting the separate cranium and the vertebral bones in order.

Fig. 1 is the reasonable reconstruction to show the general impression of the porpoise, of which every eye-witness testified to its life-likeness. The animal is said to be relatively slim in comparison with *Grampus*, to which they say that the animal seems near akin. Colour dark gray all over, but both lips are seamed with narrow white bands which expand into a node at the end of rostrum, and in the anal region, another white marking can be seen about 55 cm. long and 10 cm. wide on each side

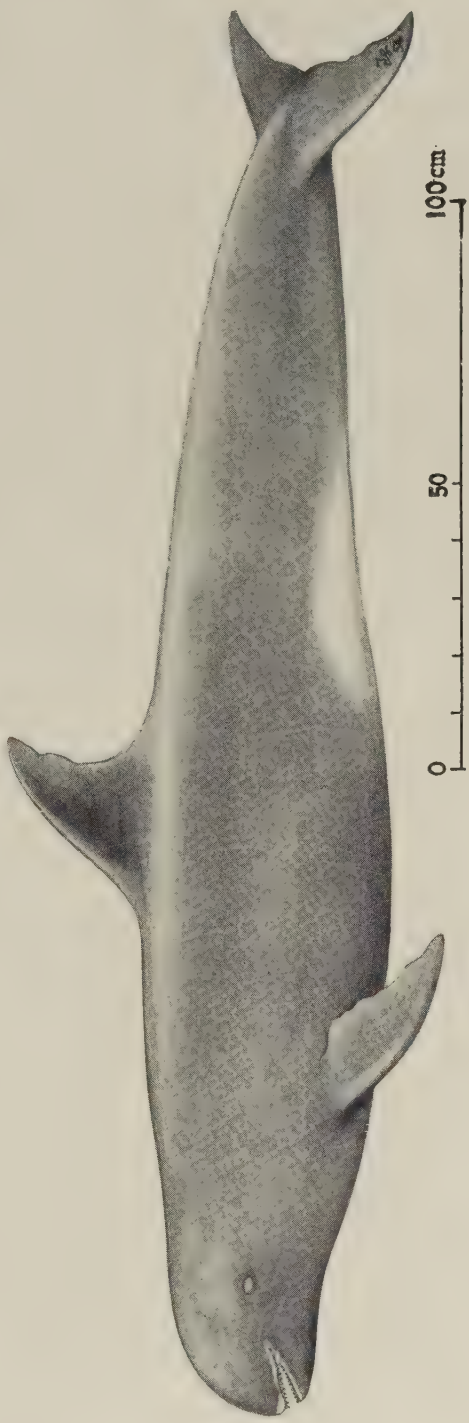


Fig. 1. *Feresa intermedia* Gray, 235 cm. long female from Taiji, after reconstruction.

from the median line, broadest around the genital orifice and tapering toward the tail. In the hyoid and pectoral regions, a somewhat paler colour is noticed, and the under side of tail flukes is also paler than the dorsal side. Two sets of parallel white stripes are distributed on the trunk as commonly seen in many cases of cetacea. The one is less distinct and consists of four stripes with the maximum distance of 8 mm. The other consists of six distinct stripes whose distances vary from 13 to 15mm. Since the distances between the neibouring dental apices of this animal measure about 15 mm. (cf. p. 70), this last set of stripes may probably be regarded to be a bitten injury by other individual of the same porpoise. The dorsal fin (fig. 2) is tall and falcate, but it must be remarked that the position in fig. 1 is arbitrarily fixed and not certified. The flippers are falcate and of moderate length (fig. 3).

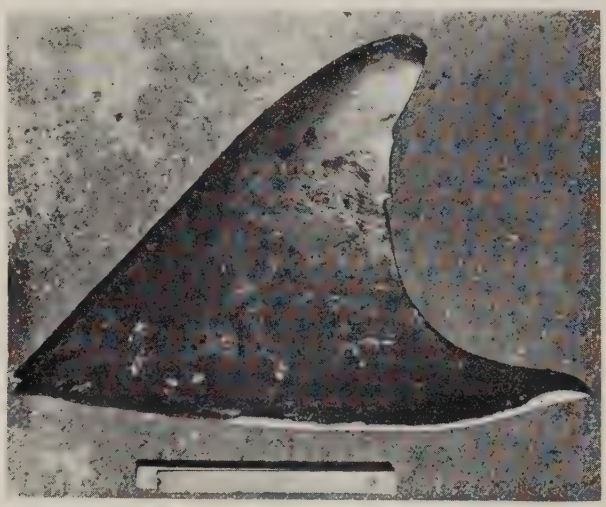


Fig. 2. Dorsal fin.

Fig. 3. Flippers, volar view.

The most important matter concerning the external characters of the porpoise is that the animal has no beak. This was absolutely certified through my blub-

ber examination and there can be no doubt as to its correctness. This is important because True (1889, p. 151) placed *Feresa* in his synoptic table next to *Lagenorhynchus*, with a question mark but as "beak distinct, short and rim-like". Therefore, this remark of True is unquestionably erroneous and should be corrected. This opinion seems to be supported by his concurrence in Gray's opinion that the animal might be allied to *Lagenorhynchus electra* Gray (True, 1889, p. 107). This problem on the position of *Feresa* has lacked the sound support until present time, and will be entered in the end of this paper.

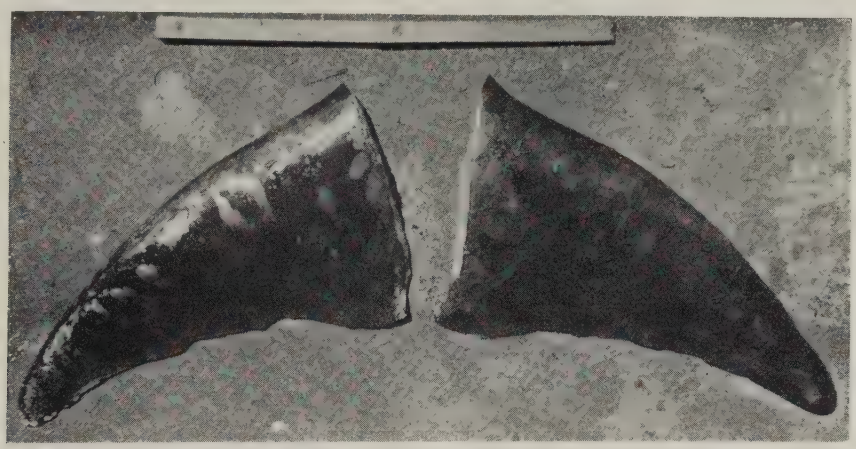


Fig. 4. Tail flukes.

Some dimensions of the exterior known after the blubber examination are given below:

	mm.
Distance between center of eye and ear opening	9.5
Length of left flipper, from head of humerus to extremity	43.5
Length of right flipper	44.3
Greatest breadth of flipper, both sides	14.2
Length of dorsal fin at base	34.0
Height of dorsal fin	23.5
Depth of rear incision of dorsal fin	4.5
Length of left tail fluke	32.0
Length of right tail fluke	34.0
Breadth of fluke at base, both sides	18.0

Osteology

Skull (figs. 5–8, tabs. 1–2): The skull of the present Taiji specimen is illustrated by figs. 5–8, and the dimensions are given in tab. 1. Comparisons are made with the previous two type skulls at the British

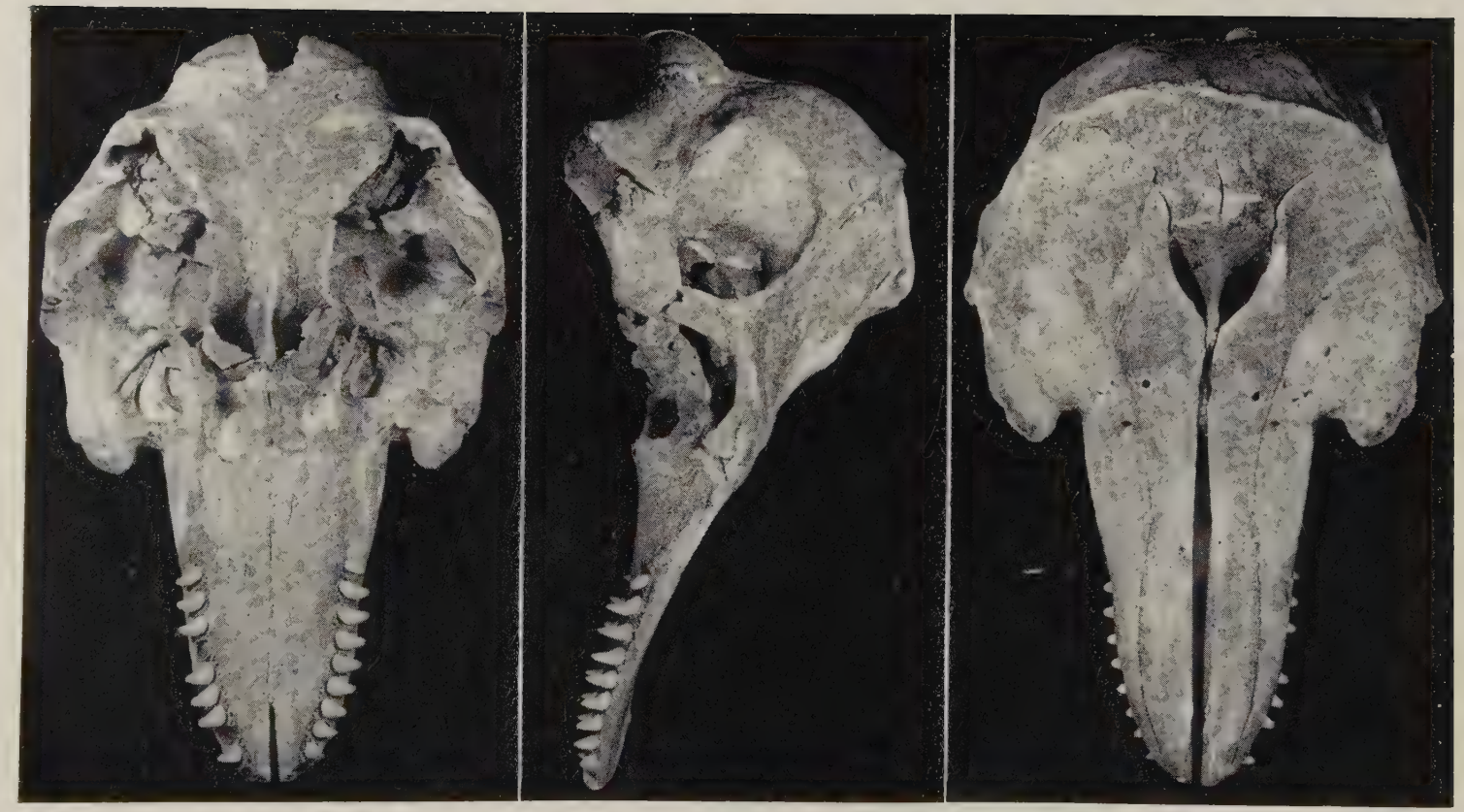


Fig. 5a. Skull of *Feresa*, Taiji specimen $\left(\times \frac{2.7}{10}\right)$. Dorsal, lateral and ventral views (top to bottom), posterior view on the opposite page (Fig. 5b).

Museum by tab. 2 through indices. This table is particularly important to identify the specimen because otherwise there are only brief descriptions available to the present comparison. In the meantime, the photographs sent by Dr. Fraser have been of course extraordinarily significant toward the present work.

The skull is robust but very short, only 16.4 per cent of the total body length. The length of the rostrum occupies nearly half of the total condylo-basal length of the skull. The rostrum is as broad, at its base, as 63.6 per cent of the rostrum length, gradually tapering in front. Accordingly, the breadth at base is least of all, though only very slightly less than the second (B. M., 1672a), in proportion to not only the skull length but also to the rostrum length.[1] However, the rostrum resembles the first specimen (B. M., 362a) in its form rather than the second. The second shows the slight lateral expansion of the rostrum near the base, which is however, less developed in the first as well as in the present. And the rostrum of the second seems to taper more sharply than the present because it is narrower at middle of the rostrum in spite of its proportionally broader base, though broader quite slightly. From the tip of the rostrum back to the nasals, the upper surface of the rostrum as well as the posterior portions of the premaxillae are gently bent back, being also concave transversely. This transverse concavity is most noticeable across the base of the rostrum, becoming flat anteriorly and only at the end turning into a convexity. After the photographic comparison, it seems probable that the convex surface of the rostrum is the well marked peculiarity of the present skull. The premaxillae are broad especially toward the end of the rostrum, and between their inner borders there lies a considerable space throughout. In this median space between the premaxillae, the vomer is visible nearly to the end of the rostrum.

Fig. 5b. Posterior view of skull $\left(\times\frac{2.7}{10}\right)$.

The superior nares open obliquely forward between the posterior

1) Length-breadth rostrum indices: B. M., 362a 69.4; 1672a 63.7.

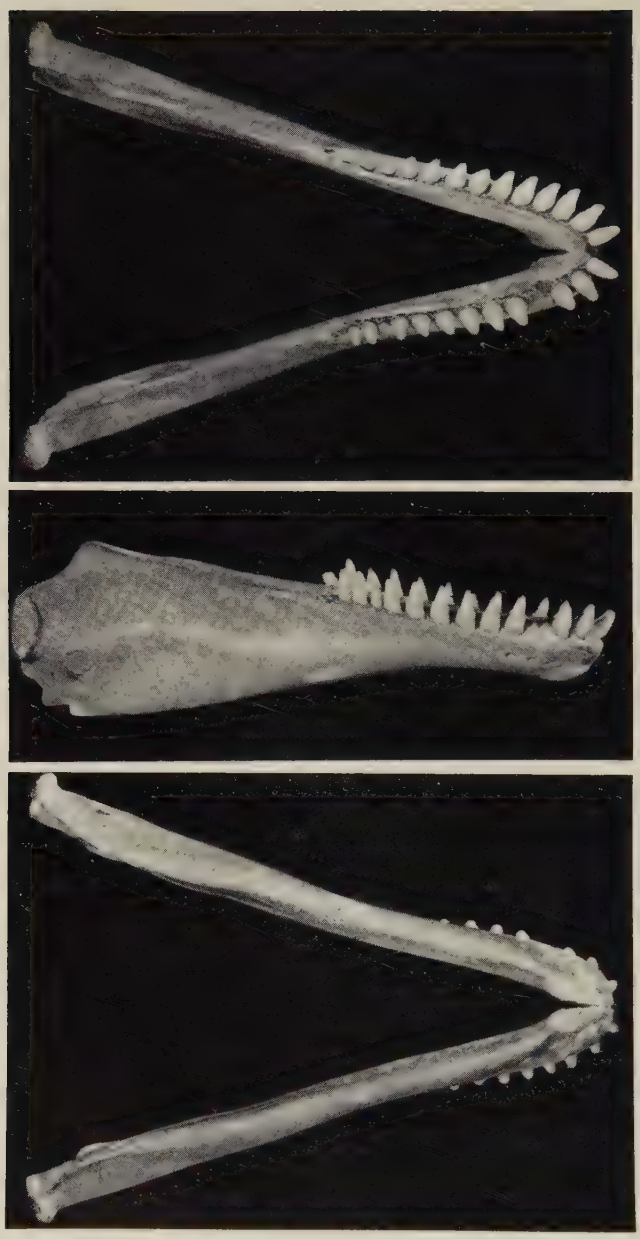


Fig. 6. Mandible of *Feresa*, Taiji specimen $\left(\times\frac{2.7}{10}\right)$. Dorsal, lateral and ventral views (top to bottom).

ends of the premaxillae and along the sloping median crest of the mesethmoid. They are narrowed anteriorly and dislocated slightly to the left together with the nasals as a sign of moderate asymmetry common to all odontocete skulls. The backward telescoping of the supra-orbital plate of the maxillae apparently hesitates to pass back beyond the nasals, which are considerably separated from the occipito-frontal crest. To the result of this, rather large area of the frontal bone is exposed on the vertex. The median suture between the nasals remains still distinct, but between them and the frontal bone, the suture is very obscure, being absorbed almost perfectly. So far as apparent by the comparison through photographs, the synostosis between the nasal and the frontal is, in the present skull, stronger than either of the previous specimens. The post-orbital processes of the frontal are stronger.

Table 1. Skull dimensions of Taiji specimen, 235 cm. long female. Straight dimensions are given unless noticed.

	mm.	per cent of length	per cent of breadth
Total (condylo-basal) length	385	*100.0*	160.3
Length of rostrum (median)	184	47.8	76.7
Breadth of rostrum at base	117	30.2	48.8
Breadth of rostrum at middle	89	23.1	37.1
Premaxillary breadth at middle of rostrum	57	14.8	23.7
Greatest premaxillary breadth proximally	87	22.6	36.3
Greatest premaxillary breadth distally	60	15.6	25.0
Length of left premaxilla	275	71.5	114.5
Length of right premaxilla	301	78.2	125.3
Length of nasal suture line	32	8.3	13.7
Greatest breadth of nasals	55	14.3	22.9
Greatest breadth of superior nares	51	13.3	21.3
Distances from tip of rostrum to bottom of maxillary notches*	195	51.6	81.2
Distances from tip of rostrum to anterior end of vomer	39	10.1	16.2
Distances from tip of rostrum to anterior end of presphenoid	164	42.6	68.4
Distances from tip of rostrum to anterior margin of superior nares	228	59.2	95.0
Distances from tip of rostrum to posterior end of mesethmoid	289	75.0	120.3
Distances from tip of rostrum to nasal vertex	295	76.6	122.9
Distances from tip of rostrum to occipito-frontal vertex	349	90.6	145.3
Distances from tip of rostrum to posterior median end of maxillae on palate	177	46.0	73.8
Distances from tip of rostrum to vomerine process between palates and pterygoids	218	56.6	90.8
Distances from tip of rostrum to posterior end of vomer on cranial basis (median)	289	75.0	124.5
Distances from tip of rostrum to bottom of right tubal notch	240	62.3	100.0
Breadth across middle of orbits	216	56.1	90.0
Greatest breadth across supra-orbital plates of maxillae	214	55.6	89.2
Greatest breadth across post-orbital processes	240	62.3	*100.0*
Breadth across zygomatic processes	237	61.5	98.7
Breadth across posterior margins of temporal fossae	155	40.3	64.6
Greatest breadth of cranium at parietal region in temporal fossae	171	44.5	71.3
Length of temporal fossae*	93	24.2	38.7
Depth of left temporal fossa	67	17.4	27.9
Depth of right temporal fossa	76	19.8	31.7
Length of left maxillary tooth row	118	30.7	49.2
Length of right maxillary tooth row	121	31.4	50.4
From last tooth to bottom of maxillary notches*	75	19.5	31.3
Breadth of occipital foramen	40	10.4	16.7
Breadth of occipital condyles	98	25.4	40.8
Length of left condyle	55	14.3	22.9
Length of right condyle	56	14.5	23.3
Height to nasal vertex at status of horizontal supra-orbital plate	177	46.0	73.7
Length of mandible (median)	283	73.7	117.8
Length of mandibular rami*	300	78.0	125.0
Distance from end of mandible to left coronoid process	265	68.8	110.3
Distance from end of mandible to right coronoid process	263	68.3	109.5
Length of symphysis	30	7.8	12.5
Length of left mandibular tooth row	140	36.4	58.6
Length of right mandibular tooth row	142	36.9	59.2
Length of left mandibular hiatus	126	32.7	52.5
Length of right mandibular hiatus	128	33.2	53.3
Depth between angle and coronoid process*	82	21.3	34.2
Breadth across mandibular condyles	210	54.5	87.5

* equal on both sides.

Table 2. Skull proportions in per cent of total skull length.

	B. M., 362a after Gray*		B. M., 1672a after Gray*		Taiji specimen
	mm.	per cent	mm.	per cent	per cent
Total length	362	*100.0*	350	*100.0*	*100.0*
Length of rostrum	173	47.4	168	48.0	47.8
Breadth of rostrum at base	120	33.2	107	30.3	30.2
Breadth of rostrum at middle	89	24.6	75	21.4	23.1
Breadth of premaxillae at middle of rostrum	61	16.9	52	14.9	14.8
Greatest breadth of premaxillae	91	25.1	91	26.0	22.6
From end of rostrum to anterior margin of superior nares	226	62.4	221	63.2	59.2
Breadth across orbits	211	58.3	201	57.4	56.1
Breadth across posterior margins of temporal fossae	153	42.3	173	49.4	40.3
Length of temporal fossae	92	25.4	84	24.0	24.2
Depth of temporal fossae	73	20.2	74	21.1	*l* 17.4 *r* 19.8
Length of maxillary tooth row	129	35.6	127	36.3	*l* 30.7 *r* 31.4
From last tooth to base of maxillary notch	51	14.2	55	15.7	19.5
Length of mandible	289	79.8	280	80.0	73.7
Length of symphysis	30	8.3	34	9.7	7.8
Length of mandibular tooth row	135	37.3	136	38.0	*l* 36.4 *r* 36.9
Depth between angle and coronoid process	79	21.8	73	20.9	21.3

* From True, 1889, p. 107.

The base of the skull is all the same except one remark of longer basi-occipital bone, apparently in relation with the longer neurocranium of the present skull. The results of this are: the smaller angle between the zygomatic processes, the longer expansion of the otic region backward[1)] and the stronger backward bulging of the occipital condyles. The peculiar condyles of the present skull, which bulge out especially at the bottom, may result, in my opinion, the stronger dorsal flexion of the entire head in comparison with the previous specimens. The styloid and very slender jugal processes are broken in the specimen, but their

1) In delphinidae, for example in *Globicephalus* (cf. Yamada, 1953, fig. 16), the otic region expands backward with the advance of age. The backward expansion of the region in the present skull, therefore, may possibly be this type of change rather than the result of the longer neurocranium. The smaller angle between the zygomatic processes also may have a close correlation with the expansion of the otic region.

heads are united with the zygomatic processes near the end. The squamosal bones are the only portion left to rattle considerably. The maxillary alveoli are ten on the left, and eleven on the right. These alveoli are confined to the anterior three-fifths of the maxillary borders, to the shortest range among the three.

Fig. 7. Tympano-perioticum of *Feresa* (nat. size). Complete right bones (right), medial and lateral views (top and bottom); dislocated left bones (left), ectal and ental views (top and bottom); tympanic ossicles: dislocated malleus, incus and stapes (left to right) are shown.

The tympano-periotic bones closely resemble those of *Grampus* and *Globicephalus*, but they are of smaller size (fig. 7). The tympanic bullae are rather rounded at the anterior end, so resemble *Grampus;* whereas the periotic bones are smooth above, particularly toward the anterior

end, so resemble *Globicephalus*. The mastoid processes are, however, intermediate between the mentioned two genera, hence rather well developed in the delphinidae family (Yamada, 1953, pp. 19–25, figs. 7–8, 17). Some dimensions (mm.) of the tympano-perioticum are given as follows:

	left	right
Length of bulla	39.0	39.0
Greatest breadth of bulla across proximal involucral end and sigmoid process	29.3	29.0
Breadth of bulla in front of sigmoid process	23.5	23.0
Length of perioticum from anterior end to posterior edge of mastoid articulation	36.2	36.0
Total depth of tympano-perioticum at middle	33.5	33.0

The incus is thicker than those genera, while the stapes is also thicker but less tall (fig. 7).

The mandible is proportionally shorter than the previous specimens, only 73.7 per cent of the skull length. However, this being the median dimension, each ramus is naturally longer than this (78.0 per cent) and approaches nearer to the Gray's measurements, which I hope to be the straight length of the rami instead of the projected length like mine. The form of the present mandible rather resembles the second specimen than the first, but the symphysis is shorter. The mandibular alveoli are thirteen on both sides, but the fourth of the right is embedded and indicates that the tooth was lost some time in the animal's life. The mandibular tooth rows mark the shortest development in spite of the larger number of the teeth.

The dental formula of the present specimen is $\frac{11-10}{13-13}$. The teeth are conical and proportionally very large, somewhat larger than the previous specimens (Flower, 1883, p. 510), the crowns being in life about 10 mm. tall out of the gum. The fourth on the right mandible was of course lost in life, and the last of the same series sprouts out of the gum only by the apex. The apices of the first maxillary teeth are bilaterally distant about 30 mm. from each other, and in each row of both jaws, the neibouring apices are distant not more than 15 mm. The most typical teeth of each jaw are illustrated by fig. 8, which shows the divergence especially between the roots. The roots of the mandibular teeth are longer, and develop into the remarkable diameter up to 10 mm. They are, both in the form and size of these major roots, not unlike peanuts. Whereas the maxillary teeth are marked by the refraction at the neck with the roots bent back toward the condyles. The difference

is caused by the shallower and more or less obliquely placed alveoli in the maxillae, which are often the case with other delphinids. But the alveoli are relatively very shallow in both jaws and do not support the large roots well.

The all findings about teeth well indicate, together with the high solidity of the entire skull, apparently the highest of all, that the animal is full-grown and probably of late age. It is apparent that this specimen attains the highest maturity of all because the first specimen, which is judged more mature than the second, has the manibular rami ununited. Concerning the greater number of the dentition in the second specimen, Flower wrote that the first, more mature, specimen had seemingly lost some teeth at the end of the series, which are present in the second (loc. cit.). However in my opinion, this may be in the range of individual variation from animal to animal because of the greatest number present in the Taiji specimen in spite of its highest maturity. The attenuate rostrum of the second skull is, according to Flower (loc. cit.), that of the younger animals as seen in *Orca* and *Globicephalus*, but the present skull appears to attach a suspicion also to this opinion, though I agree with him on the general tendency in question.

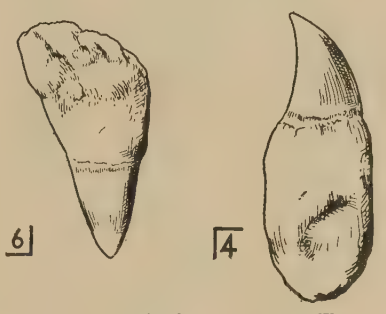


Fig. 8. Typical teeth of *Feresa* (× 1.5). Right maxillary 6th, seen from side and above (left), and left mandibular 4th, rostral view (right).

The hyoid as well as the hyals are all missing.

Vertebrae (figs. 9–12, tab. 3): The total number of the vertebrae of this specimen is 67 with the formula of C_7, D_{12}, L_{16}, Ca_{32}. Fig. 9 and tab. 3 are especially referable to the general account on the vertebrae.

Cervicals: The bodies as well as the neural arches of the first three vertebrae are united, but the third is joined with the second by a partial ankylosis at the bottom of body and the arch (figs. 9–10). The segments posterior to the third inclusive are very thin plates, namely very short, of which the fourth is the thinnest and the rest gradually grow thicker and stronger. The seventh is, however, comparatively thick, being twice in proportion to the fourth and comparable with the second. The neural arches of the posterior thin vertebrae are likewise weak, of which the fifth attains the minimum. The development of the arches shows a close relationship with that of the transverse processes, which extend, as in other cases of cetacea, most remarkably in the first and the second,

Table 3. Dimensions of vertebrae (mm). Note: Since C_{1-3} are consolidated, 1) is length of body C_{1-3} at base; 2) is breadth across articular surfaces of atlas. * Not given, because measuring point is difficult to find.
** United vertebrae, see text.

	Vertebra no.	Length of body at center	Height of body at front end	Breadth of body at front end	Total height from anterior bottom	Bilateral breadth of transverse processes	Greatest height of neural canal	Greatest breadth of neural canal
C	1st	39[1]	*	97[2]	90	141	*	48
	2nd	—	—	—	—	102+	—	—
	3rd	—	—	—	—	68	25	36
	4th	3.5	38	36	70	53+	24	31
	5th	4.3	36	35	64	51	24	31
	6th	6	35	38	68	53	24	36
	7th	8	37	41	68	94+	31	43
D	1st	12	36	42	84	108	30	46
	2nd	16	37	43	93	111	29	43
	3rd	22	37	45	102	112	32	43
	4th	23	33	40	105	113	37	42
	5th	26	33	37	102	118	41	43
	6th	30	34	37	98	120	36	42
	7th	31	33	36	101	126	33	40
	8th	32	33	37	102+	133	32	40
	9th	32	34	38	105	141	28	35
	10th	32	35	38	108	155	29	32
	11th	31	37	40	115	178	28	29
	12th	30	35	39	124	198	30	29
L	1st	30	36	40	129	205	31	27
	2nd	30	36	40	133	205	34	26
	3rd	29	37	40	136	205	36	23
	4th	28	36	40	142	203	34	23
	5th	28	36	39	143	199	34	22
	6th	27	37	40	146	194	35	22
	7th	27	38	40	149	192	35	20
	8th	27	38	41	150	188	35	19
	9th	26	37	39	152	178+	36	19
	10th	26	38	41	155	177	35	18
	11th	26	39	39	154	174	34	17
	12th	27	41	42	153	168	34	15
	13th	26	41	42	149+	162	34	14
	14th	27	41	42	130+	161	35	13
	15th	26	44	46	136	160	32	13
	16th	27	43	43	131	158	30	13
Ca	1st	27	43	43	126+	138+	30	12
	2nd)**	61	43	43	124	123+	29	11
	3rd)		—	—	—	122+	—	10
	4th	27	46	43	99+	104+	29	9
	5th	28	45	44	110	113	25	8
	6th	27	44	44	108	113+	23	7
	7th	27	45	46	102	110	19	6

(*continued*)

Table 3 (*continued*). Dimensions of vertebrae (mm).

Vertebra no.	Length of body at center	Height of body at front end	Breadth of body at front end	Total height from anterior bottom	Bilateral breadth of transverse processes	Greatest height of neural canal	Greatest breadth of neural canal
Ca 8th	28	46	45	97	108	15	6
9th	28	45	45	97	101	8	5
10th	28	45	45	90	92	7	5
11th)**	63	45	44	88	86	10	4
12th)		—	—	—	77	—	4
13th	29	48	45	77	70	8	4
14th	30	44	46	77	64	9	4
15th	30	49	50	86	51	9	4
16th	30	42	42	69+	49	7	3
17th	31	42	41	66+	44	5	3
18th	31	43	39	67	40	4	3
19th	32	44	36	60		3	3
20th	32	43	35	56+		3	2
21st	30	42	36	50		2	2
22nd	25	38	34	43		1	1
23rd	18	30	37	34			
24th	13	25	37				
25th	12	21	38				
26th	11	18	37				
27th	10	17	33				
28th	9	14	28				
29th	8	12	26				
30th	8	11	22				
31st	7	9	16				
32nd	—	—	—				

but suddenly diminish into weaker apophyses attached to each arch, and develop again in the seventh to a degree comparable with the second.

Dorsals: In this region, the first is only 12 mm. in length of the body at center, and they gradually increase from this to the eighth, the ramaining bodies being nearly equal, varying from 31 to 32 mm. The posterior five are, together with some caudal vertebrae (Ca_{19-20}), the maximum out of all in length of the body. The articular surfaces for the heads of ribs present on the hinder edge of the base of pedicle of the first six arches, of which the sixth is very small, and on the seventh there is a tubercle in the corresponding position. The spinous process of the first is slender and short, and belongs to the left lamina because of the defect of the neural arch just right to the spine. The similar incomplete arches are also the case with the fourth and the seventh cervicals. From the second to the fifth, the spines gradually grow thicker, but are rather club-shaped with pointed ends, while the re-

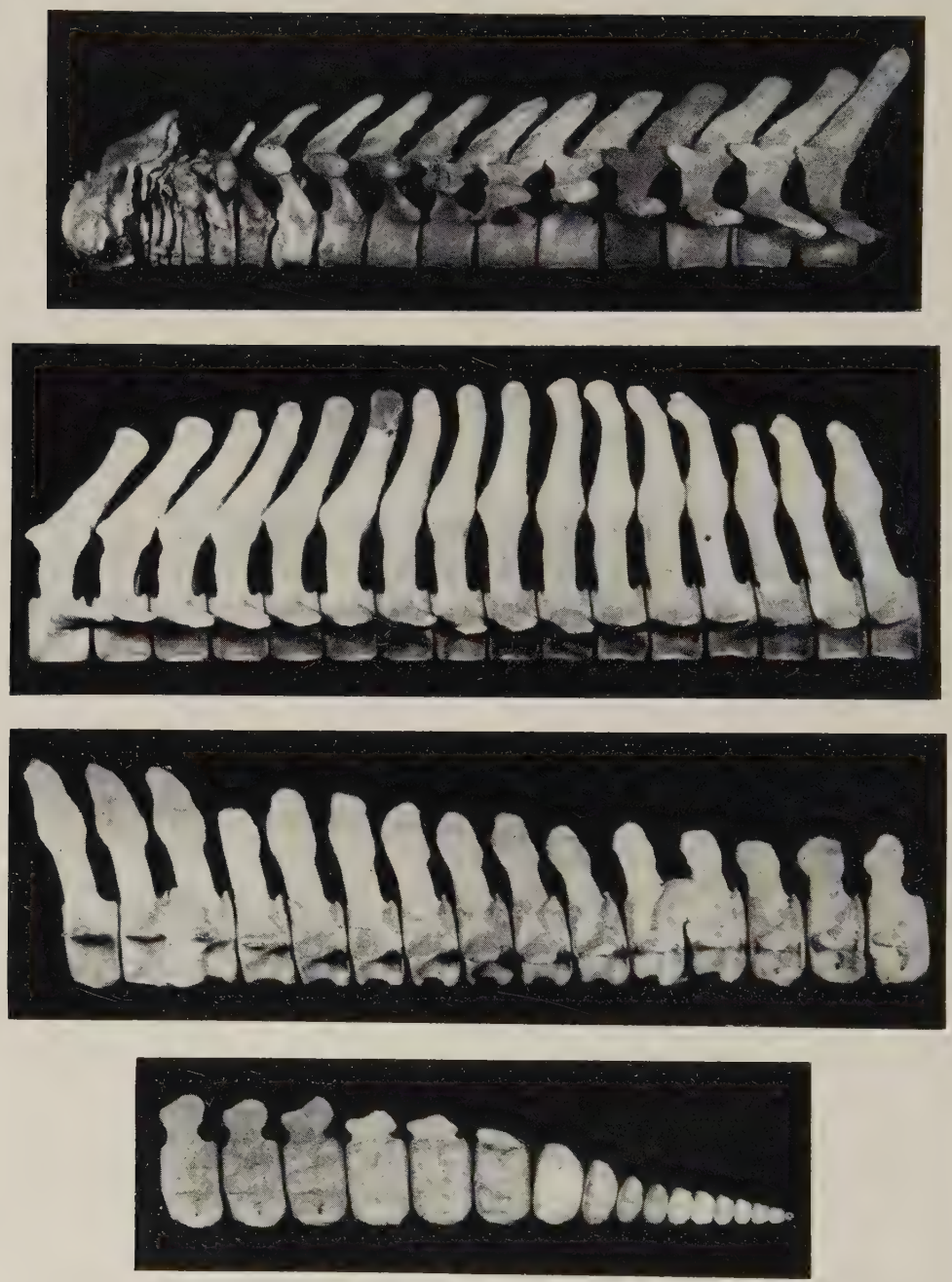


Fig. 9. Vertebrae of *Feresa* $\left(\times \frac{2.4}{10}\right)$. Cervicals and dorsals, lumbars, caudals 1–15, and caudals 16–31 (top to bottom). Left side.

mainder are flat, becoming gradually broader, and the sixth and seventh are transitions. They are all directed caudad with nearly equal inclination and with very gradual prolongation and slow increase in height. The transverse processes arise, in the anterior vertebrae, high up on the side of arch, but their position is gradually lowered toward the end of this region to the upper level of the vertebral body. This descent goes on further into the lumbar region, and it is in the posterior lumbars that the process is lowered to the middle height of the body. In the range of anterior half, the increase in length of the transverse process is very gradual from the first to the sixth in the bilateral expansion. On the extremities of the process, there are the articular surfaces for either tubercles or heads of the ribs. The transverse processes extend obliquely forward at first, but this becomes less marked as it approaches the seventh, and thenceforth the processes become directed more and more backward until the maximum at the twelfth in the entire vertebrae, the rear angle between these processes being 143°.

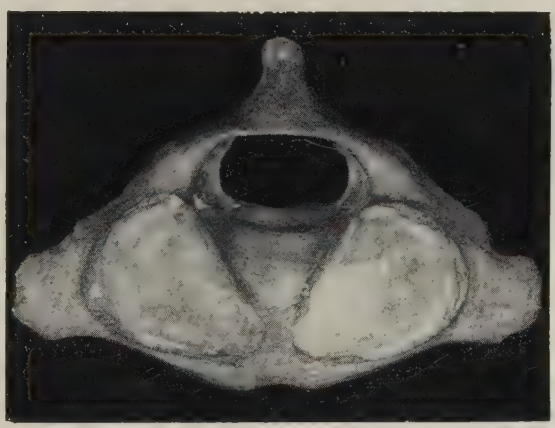


Fig. 10. United cervicals 1–3. Cranial view (ca. $\times\frac{1}{2}$).

Fig. 11. Dorsal 7th. Cranial view (ca. $\times\frac{1}{2}$).

The seventh dorsal is peculiar for its uncinate transverse process (fig. 11), apparently in concert with its ribs that first lack the neck. The uncinate portion attached to the transverse process is obviously the neck of the seventh rib, which was separated from the costal body and remains ankylosed to the process but without reaching the articular surface on the sixth vertebra. Between the uncinate processes and the articular surfaces on

the sixth body, there were probably a pair of cartilaginous connection in existence, which was lost in the course of preparing the specimen. The very small articular surfaces on the sixth are now well understood. The tubercle on the seventh as well as the faint traces of it on the following three, just in the corresponding position of the articulation, probably have some similar relation. However, it is not doubted that this is never a definite nor constant peculiarity confined to *Feresa*.

The development of the zygapophyses as well as the metapophyses is comparatively strong in the thoracic region. The zygapophyses are well developed in the anterior ten dorsals, first marking the lateral borders of the laminae, especially on the posterior edge. As it goes caudad, they ascend gradually along the posterior edge of the pedicles, and to the consequence, approach nearer each other until finally in the ninth, they are almost perfectly joined together, and in the tenth they really join into a single apophysis attached faintly but crest-like to the base of spine at the junction of the pedicles. The metapophyses are first indicated though slightly in the fifth near the medial end of the anterior edge of the transverse process. The first distinct metapophysis is a conical tubercle on the sixth, and from here caudad they gradually ascend as well along the anterior edge of the pedicles, naturally approaching each other but never to join. The metapophyses attain the maximum development at the tenth.

Lumbars: They are uniform in general. The bodies are nearly equal in length at center, becoming shorter very gradually caudad. But in the height at front end, they increase from 36 mm. (L_2) to 44 mm. (L_{15}). However, this increase in height is obviously exaggerated in some scale because of the swelling out at both ends, which occurs especially in the posterior segments. This continues further into the caudal region, where it is noticed to be a pathologic change to disappear again along with the going down of the transverse processes. The dimensional transitions of the lumbar bodies are very common in cetacea, and are in close relation with the change of form, viz., in the anterior segments, the bodies are dorso-ventrally flattened not unlike the shape of heart, and in the posterior, they approach the regular circle with some polygonal signs. The under side of the body is slightly keeled by the longitudinal crest throughout the region. The transverse processes present, in the anterior three, the greatest bilateral breadth in the entire vertebrae (205 mm.), and gradually diminish to the last (158 mm.). They gradually diminish also in breadth from 21 mm. of the anterior to 16 mm. of the last. Their strong backward inclination at the anterior, next

after the maximum at the twelfth dorsal, becomes gradually weaker until the eleventh, where the processes extend right transversely. Behind this, they show the mirror-imaged and increasing forward inclination. The neural spines are first directed caudad but gradually become upright as far back as the twelfth, and thenceforth directed gradually forward. Particularly from the tenth to the fifteenth, the spinous apices are bent strongly forward. The tallest spine is of the tenth and stands 116 mm. from base to top. The neural spines arise from rather nearer the front than the hinder end of the bodies but this is less marked in the anterior segments. The metapophyses still present markedly in the first six, but with hardly recognizable traces of the zygapophyses. These apophyses gradually ascend hand in hand on both edges of the spines, to the middle height at the thirteenth, and to the two-thirds height at the last, marking the considerable antero-posterior broadening of the flat spines. From the posterior lumbars through the anterior caudals, the vertebral bodies are distorted forward more or less strongly in concert with the forward inclination of the spines.

Caudals: The bodies of this region increase in length from the first (27 mm.) to the nineteenth and twentieth (32 mm.), after which they again diminish to the end. Therefore, the vertebrae of this specimen show the maximum development of the body length at two points, of which the first in the thoracic region was already stated. In this region, the swelling of the bodies at the ends grows much stronger than the lumbars to a pathologic degree, and really the second and third, and the eleventh and twelfth are respectively consolidated together along the borders of the facing surfaces by the irregularly expanded bone tissues which are suggestive of some pathological changes as osteoma. The bone fragments of the same nature put also some other vertebrae indirectly together, and even some chevron bones are attacked. Because of this change, the height of body is tabled with more or less exaggerations. However, the measurements show that the anterior 21 are nearly equal in height of the body, and very rapid decrease beyond them. From the eighteenth to the twenty-second the bodies are marked by the lateral compression which characterizes this part of the cetacean vertebrae, and the twenty-fourth is the first of the series of the so-called terminal vertebrae which are remarkably broad, compressed and rectangular, the twenty-third being of transitional form. The last segment was a nodule with the diameter of about 5 mm., but because of its high fragility unexpected beforehand, it was smashed between my fingers and never recovered, when I tried to know whether or not it

was really that segment at a stage in preparation. The neural spines, which arise closely to the front end of the bodies, gradually diminish in heights to the twenty-second where the spine becomes a low crest-like ridge bearing the last spinal canal. The apophyses attached to the spines are indicated by the broadening of the processes as well as the muscular lines on the side, which appear first on the second spine. They gradually ascend toward the top, resulting the antero-posterior expansion in the posterior low processes. The transverse process is reduced to a low ridge on the fifteenth, the traces of which disappear altogether beyond the eighteenth. The vascular canals, perforating the transverse process at base, first appear in the ninth and continue as far as the penultimate segment.

The chevrons are, with my confidence, 24 in number, of which the first one and the last two are ununited into halves (fig. 12). The first

Fig. 12. Chevrons of *Feresa* (ca. $\times\frac{1}{3}$). Anterior and posterior halves (top and bottom rows). Ununited laminae are shown, right side (top) and left (bottom) each.

pair is strangely long with large articular surfaces very closely located. This is strange to me but apparently not mistaken because of the good correspondence of the articular surfaces on the first caudal vertebra. Whereas the second and third remain small, provided with small articular surfaces. These three chevrons have no spines developed beyond the junction of the laminae, the last four too being the same. The fifth shows a sudden increase in length, and thenceforth the bones gradually increase to the eleventh in order to decrease again. The posterior chevrons are marked by the broad dimensions in the antero-posterior direction.

Ribs and sternum (fig. 13, tabs. 4–5): The present specimen bears

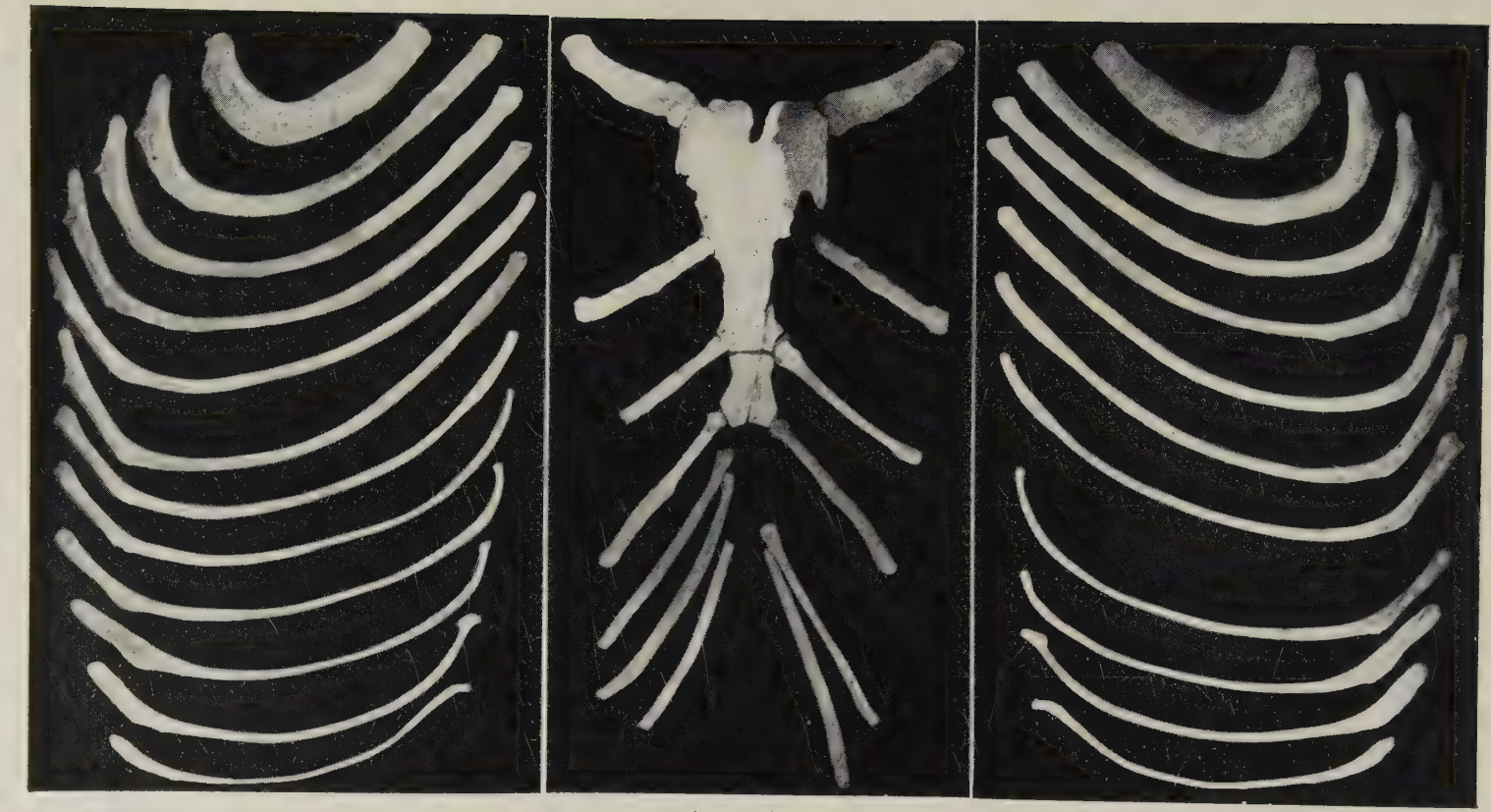


Fig. 13. Ribs and sternum of *Feresa*. Vertebral ribs $\left(\text{ca.} \times \frac{1}{5}\right)$, left and right sides, both visceral view (left and right). Sternum and sternal ribs $\left(\text{ca.} \times \frac{1}{4.5}\right)$, ventral view (center).

Table 4. Dimensions of ribs (mm).

	Rib no.	Length[1]		Breadth at middle	
		left	right	left	right
Vertebral rib[1]	1st	199	197	30	32
	2nd	335	330	17	17
	3rd	390	387	13	13
	4th	415	409	10	10
	5th	420+	412	11	11
	6th	429	413	10	10
	7th	385	384	8	8
	8th	380	—	10	—
	9th	361	365	9	9
	10th	335	333	8	7
	11th	312	320	7	7
	12th	270	274	4	4
Sternal rib	1st	98	93	20	21
	2nd	96+	94	13	12
	3rd	110	77+	8	9
	4th	115	115	9	10
	—[2]	134	140	5	7
	—	148+	154	7	8
	—		120+		7

1) To the vertebral ribs, curvilinear length (along the visceral border) is given instead of distance from end to end.

2) Ordinal number is not identified.

Table 5. Dimensions of sternum.

	mm.
Length of anterior element	147
Length of posterior element (3rd sternbra, median)	43
Greatest breadth of manubrium*	88
Least breadth of manubrium*	50
Least breadth of 2nd sternbra	28
Breadth of 2nd sternbra at posterior end	26
Breadth of 3rd sternbra at anterior end	26
Greatest breadth of 3rd sternbra	34
Least breadth of 3rd sternbra	23
Breadth of 3rd sternbra arcoss posterior articular angles	21
Distance between centers of articular facets, 1st and 2nd (right)	72
Ditto, 2nd and 3rd (right)	56

* The anterior element is broken and arbitrarily put together, hence not actual dismension.

12 pairs of vertebral ribs, but the right side eighth was lost. The anterior six pairs have necks and are two-headed. The necks are generally short in proportion to the total length, but they are well developed, together with the proximal portion to the angle of the posterior ribs without the neck, despite the rapid caudad decrease in breadth of the bodies. With exception of the anterior two or three, of which the first is broadest, most of the ribs are very slender to the extreme of the last. The first is, however, shortest of all, and they gradually increase in length until the maximum at the sixth, and thenceforth diminish to the last. From the first to the ninth, the sternal ends have facets to be covered by cartilage, for the attachment of either the sternal ribs or cartilages. Meanwhile, the remainder have peculiar extremities to expand into unusual swellings which end freely, flattened, directed and pointed caudad.

After examining the vertebral ribs, I have come to expect the presence of eight or nine pairs of the sternal ribs, but only 13 have been secured in the specimen. Four pairs are in the direct and independent connection with the sternum, and exactly identified to be at time of securing the specimen. The first pair is especially thick but short, and with its large head the pair articulates the sternal manubrium near the anterior angle of that bone. The second pair articulates at the border of the first and second sternbrae, the third at the posterior angle of the second, and the forth the third. I identify, next to these four, two more pairs and one single rib to articulate to the end of the third sternbra. From the first to posterior, they grow gradually slender but longer.

The sternum consists of two elements, of which the anterior is seemingly composed of two sternbrae consolidated together, hence the total of three segments is certified. The anterior element bears three pairs of articular facets for the sternal ribs, and across the second facets, a dim trace of the synostosed border is noticed especially on the visceral surface. The longitudinal shallow groove on the ventral surface throughout indicates the primordial median fissure, which is indicated also by a sharp jugular incision as deep as 30 mm. in front. Behind the joint for the first sternal ribs, the manubrium expands greatly toward the sides, with the anterior tubercles ventrad and with the posterior processes caudad. The posterior process on the left is however, sharply pointed longer than the right one, and resembles some true dolphins as *Delphinus* and others which usually bear the similar processes on the manubrium. On the ventral surface of the element, there are,

across the median groove, two pairs of tubercles or tuberosities at middle of each halves. Concerning the small posterior element, i.e., the third sternbra, no particular description seems necessary other than the dimensions given in tab. 5.

Pectoral limb (figs. 14–15, tab. 6): Scapula: The form of the present scapula does not differ much from that of other delphinids except the caudal angle, where there are two angles of some distance

Fig. 14. Scapulae of *Feresa* ($\times \frac{1}{3}$). Dorsal view of left and costal view of right (right and left).

(tab. 6). The most noticeable character of the scapula is, however, the peculiar rough nature on the surfaces. The body is so rough that even the dorsal or lateral surface is marked by the irregular and rough elevations as well as impressions. The anterior angle of the blade turns dorsally, and there and along the vertebral border, the surface is marked by a large number of minute but sharply impressed foveae left among the network of bone trabeculae. The costal surface is divided by a noticeable transverse elevation roughly into two triangular fossae. This elevation laterally joins the strong axillary frame along that border, in order to support the glenoid cavity. The anterior fossa exceeds the posterior, and mainly in the former there are at least four distinct ridges, known as the muscular lines for the tendinous intersection of the infrascapular muscle, which run toward the glenoid angle, giving

more or less sharp elevation to the surface. In these fossae and along the vertebral border, the blade is very thin and perforations are present in the specimen. The acromion is of nearly equal breadth from base to tip, and turns midway strongly toward the vertebral border. The coracoid process has a narrow neck and expanded extremity. The glenoid cavity is deep.

Table 6. Dimensions of pectoral limb bones (mm).

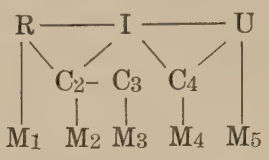
		left	right
Scapula	Length along vertebral border	200+	211
	Greatest breadth	158	157
	Length of glenoid cavity	36	37
	Breadth of glenoid cavity	28	32
	Length of acromion, along medial border	44	41+
	Greatest breadth of acromion	27	29
	Length of coracoid, from supraglenoid edge to tip	47	50
	Greatest breadth of coracoid	34	34
	Length of caudal angle	50	43
Length of humerus		76	75
Breadth of humerus at distal end		55	53
Length of radius		100	100
Breadth of radius at distal end		51	51
Length of ulna		93	90
Breadth of ulna at distal end		48	48
Length of metacarpus	I	28	29
	II	47	48
	III	50	49
	IV	36	35
	V	33	31

The free bones of the limb are all very broad in proportion to the length. The humerus, radius and ulna nearly resemble those of *Grampus* and *Globicephalus*, being united in this specimen immovably altogether. To the distal end of the ulna, the pisiform bone of triangular form is attached medially, though fused immovably but with a distinct mark of demarcation.

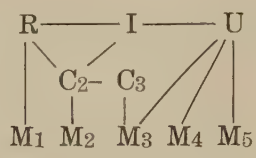
There are only four carpals in the manus, of which the three belong to the procarpus, and the mesocarpus presents only one, i. e., the trapezoid bone. The radial (scaphoid) and ulnar (cuneiform) procarpals are particularly broad. The most remarkable peculiarity of these carpals is, however, the disappearance of the hamate or unciform bone. Con-

Fig. 15. Bones of left flipper of *Feresa*, volar view ($\times \frac{1}{4}$). Note especially carpals, *R* scaphoid, *I* lunar, *U* cuneiform and *T* trapezoid. No hamate. Pisiform united to ulna.

cerning the carpals of delphinids, Weber presents the following schema[1] (1928, p. 368):



which should be modified in *Feresa* into another formula given below.



The phalangeal formula of *Feresa* including the metacarpals is: I_3, II_9, III_8, IV_4, V_2.

Because of the particular importance of this specimen, the above formula was certified with a special care, and there can be no doubt as to the correctness. The flippers have been, for this purpose, left on a tray for beetles who have eaten up the soft parts and left some ununited phalanges at the spot. This is also the reason why the manus is illustrated by drawing instead of photograph (fig. 15).

All the metacarpals and the phalanges are perfectly built with exception of the phalanx of the fifth digit on the right, where the phalangeal body is separated from the epiphysis, and this is in turn united with the head of the metacarpus. These bones are all in close contact to each other and really synostosed relations are very popular. The fifth digit is marked above all by the strong medial divergence with very broad metacarpus and phalanx.

Pelvic bone: The vestiges of the pelvic girdle have escaped from the present examination, and are missing in the specimen.

Position of *Feresa*

1827. *Delphinus intermedius* Gray, Ann. Phil., p. 396.

1) *R* scaphoid; *I* lunar; *U* cuneiform; *C* mesocarpals and *M* metacarpals; attached are digit numbers.

1843. *Grampus intermedius* Gray, List of Mamm., p. 106.
1846. *Orca intermedia* Gray, Zool. Ereb. & Terr., p. 34, tab. 8.
1850. Cat. of Cetacea (1st ed.), p. 96.
1866. Cat. of Seals and Whales, 2nd ed., p. 283.
1871. *Feresa intermedia* Gray, Suppl. Cat. of Seals and Whales, p. 78.
1875. *Feresa attenuata* Gray[1], J. du Mus. Godeffroy, Heft 8.

These are the principal synonyms of *Feresa*, of which the last was given to the second specimen (B. M., 1762a). They are interesting not only because all was described by a single cetologist, J. E. Gray on the two skulls, but also because I see, in the course of change, irresolute considerations of the author himself, who finally created an independent genus, *Feresa* Gray in 1871.

However, Gray simultaneously noted the first specimen (B. M., 362a) to have many resemblances to *Lagenorhynchus electra* Gray (1870, p. 77), and wrote: "Indeed, when the animal is known, I should not be at all astonished if it should prove to be a species of *Electra* rather than *Orca*, or perhaps a new genus" (1871, p. 78). Also Flower (loc. cit.) wrote: "the cranium and teeth indicate that it is a connecting link between *Globiceps*, *Grampus* and *Lagenorhynchus*". Since I have no means to examine the specimens of *L. electra*, I knew all about it through literatures including True's monograph (1889., pp. 100–103, pl.

1) This list of synonymy is given after True (1889) with some modifications of myself. True gives the last synonym as *Feresia attenuata* instead of *Feresa*. Flower (1883, 1885) cited Gray (1871 and 1870 respectively) as *Feresia* Gray, which is however never read so in the originals, but *Feresa* Gray (1871 only; subgenus *Feresa* 1870 as indicated by Gray in 1871 seems to me a misunderstanding of Gray himself). Therefore, this is the mistake of Flower which brings this wrong name into the synonymy of *Feresa*. As I could not see the Gray's original description on the second specimen (1875), I liked to know the relations between *Feresa* and *Feresia* in that case. According to the personal information from Dr. Fraser in reply to my inquiry, True is wrong in stating *Feresia attenuata*, hence exclusion of *Feresia* from the above list. I myself too have later learned by the title of Gray's report in 1875 that it was never *Feresia*. But with this correction the synonym given by True is that what should be used. The reason why I mention this is for the confusions possibly caused by the inattentative use of these synonyms. For example, Beddard wrote once as *Feresa* (1900, p. 292), while later as *Feresia* (1923, p. 337). Weber wrote *Feresia* among the important genera in his synoptic table (1928, p. 389) without giving correct *Feresa*. Winge's work (1942) gives *Feresa* in the text (p. 252), but only *Feresia* in the notes (p. 273). The last is understood because this is cited from Flower (1886), but it is never understood that no authors mentioned above give any word of notice concerning the identity of *Feresa* and *Feresia*. The genus is little known, so this seems important, and confusions must be avoided by use of the correct name or by the careful usage of synonymy.

28), but I cannot bring myself to concur in the opinion, though I accept some resemblances in the skull. This is because of the noticeable dispersions in the external characters known after my reconstruction (fig. 1) as well as in the dentition, roughly half-numbered and of very large teeth. I think that the skull of *Feresa* resembles that of *Orca* rather than *L. electra* by putting the special weight in the resembled dentition, both in the number and form. The tall dorsal fin and the white marking on the vent may be other resemblances to *Orca*. In the meantime, the vertebral formula seemingly interlinks between the genera, *Orca*, *Grampus* and *Globicephalus*. In conclusion, all genera to be considered pertaining to the position of *Feresa* are, in my present opinion, *Grampus*, *Globicephalus* and *Orca*, which possibly include *Pseudorca*. And I believe very adequate position of *Feresa* at the independent generic rank. I admire Gray for this reason, and also for his prudence not to have placed our *Feresa* under *Lagenorhynchus*, in spite that he might appeal to do so. With special interest as intense as the authors did in the past (Flower, 1883, p. 510; True, 1889, p. 107), I shall look forward to the future development of our knowledge of this porpoise, and would like to put to it a name, the "Lesser" or "Pygmy Killer".

Distribution

The habitat of *Feresa* has been as well very little known, but it has been expected that the Pacific waters might be the important range because the second specimen was known from the South Seas. The present specimen has unveiled that the Pacific waters are really the principal habitat, expanding its distribution into the wider range which includes the northern part in addition to the South Seas.

Summary

A 235 cm. long female porpoise *Feresa intermedia* Gray was captured on August 23rd, 1952 at Taiji, Wakayama Prefecture, Japan. This is the third, but the first complete *Feresa* specimen. Since our knowledge has been confined to skull (two type specimens B. M., 362a and 1762a), detailed description and measurements are given, being summarized as follows:

Colour dark gray all over, with white marking on the vent, lips seamed with white band. Head very short, caudal portion long. No beak, with rounded forehead but not so strong as *Grampus* and *Globi-*

cephalus. Teeth 11–10 to upper, 13 to each side of lower jaw. Crowns very large, conical. Flippers develop moderately.

Size of skull exceeds two types. This is presumably of highest maturity, but with narrow rostrum and greatest dentition number. Rostrum concave or flat above, and only at end slightly convex. Tympano-perioticum like *Grampus* and *Globicephalus* but somewhat smaller, with well developed mastoid process. Condyles bulge out at bottom stronger backward. Vertebral formula C 7, D 12, L 16, Ca 32, total 67. C_{1-3} united. Articular apophyses well developed. Neural spines bent caudad as far back as the erect one of L_{12}, beyond this forward. Chevrons 24. Vertebral ribs 12 pairs, of which 6 pairs have necks. Mostly very slender. Sternal ribs expected 8–9 pairs, but 13 in the specimen consist of 4 pairs in direct and independent articulation with sternum and not certified posterior ones to close thorax behind the end of sternum. Sternum consists of 3 sternbrae, 2 anteriors united. Manubrium large, with a deep jugular incision at front end. Scapula very thin, roughly waved on both surfaces. Only 4 carpals in manus, because of disappeared hamate. Phalangeal formula I 3, II 9, III 8, IV 4, V 2 including metacarpals. Hyals including hyoid, some sternal ribs and pelvic vestiges are not secured in the specimen.

These findings of exterior as well as osteology well support Gray's opinion as seen in synonymy given by himself, but to kinship of *Feresa* to *Lagenorhynchus electra* mentioned by Gray, Flower and True, I cannot yield. *Grampus*, *Globicephalus*, *Orca* and possibly *Pseudorca* may probably be near allies involved in the consideration of the position of *Feresa*. Proposition of a new name "Lesser" or "Pygmy Killer" to *Feresa* may be an idea. Our Taiji specimen expands its distribution to the Northern Pacific, besides the South Seas of *F. attenuata*.

All photographs are made with Leica with under mentioned lenses and devices. These data are appended as they may eventually help the understanding of figures in respect of the perspective of the specimen.

Figs. 2–4. Elmar 50 mm.
Figs. 12–15. Elmar 50 mm., with focusing stage.
Figs. 7, 10–11. Hektor 135 mm., with focusing bellows and mirror reflex housing.
Figs. 5–6, 9. Telyt 200 mm.

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Sei Whales in the Adjacent Waters of Japan. II. Further Studies on the External Characters.

By

Hideo Omura and Kazuo Fujino

Introduction

Omura, Nishimoto and Fujino (1952) stated, after investigating the body proportions and other characters of the sei whales taken in the waters adjacent to Japan, that two types of sei whales, namely the northern and the southern types, are both found in the adjacent waters of Japan. They concluded further that the former belong to the ordinary sei whales (*Balaenoptera borealis*) but the latter are more related to the bryde's whales (*B. brydei*) than the ordinary sei whales. As the most distinct differences between the two types in the external characters are (1) the shape and the quality of the baleen plates and (2) the extent of the ventral grooves, the present authors made further investigations mostly on these two points, results of which are reported in the present account.

We are much indebted to the Japanese government whaling inspectors and the staff of the whaling companies who cooperated in the present investigations. Our sincere thanks are due to Dr. F. C. Fraser of the British Museum (Natural History), who kindly gave Omura a chance to read some literatures kept in that museum while the latter stayed in London.

Material

We made the following scheme of investigation prior to the commencement of the whaling season for baleen whales 1952 in the adjacent seas of Japan.

1. A biggest baleen plate should be taken from right or left row of each sei whale captured and such baleen plates should be sent to the laboratory with the particulars of the said whale for the identification of the two types and for the measurement of their length and breadth.
2. The extent of the ventral grooves of each whale should be observed, classifying the following three classes.

The ventral grooves end
- (a) anterior to the umbilicus,
- (b) at the umbilicus, and
- (c) posterior to the umbilicus.

Baleen plates were taken for the investigation from almost all sei whales caught by the pelagic whaling in the waters around Bonin Island and in the northern Pacific. However, regarding those of sei whales processed at the various land stations only about forty per cent of the total catch were sent to the laboratory. Furthermore, some plates were broken in their inner parts in the course of transportation, especially in those taken in the Bonin Island waters. Besides, in some plates the margin line of the gum were not clear because of the carelessness at the time of sampling. Such baleen plates were of course available for the identification of the two types, but were not of use for the measurements. Table I shows the total number of sei whales taken in 1952 and those of which baleen plates were measured.

Table 1. Number of Sei Whales taken and Number of Baleen Plates measured in 1952.

Geographical Areas	Number of Sei Whales taken			Number of Baleen Plates measured		
	Males	Females	Total	Males	Females	Total
Bonin Island (Pelagic)	270	141	411	164	101	265
Coastal	275	390	665	94	141	235
Northern Pacific (Pelagic)	8	6	14	4	4	8
Total	553	537	1,090	262	246	508

As shown in this table, about a half of the total sei whales catch in the waters of Japan, Bonin Island and northern Pacific (pelagic) were measured of their baleen plates.

Observations on the extent of the ventral grooves were made by Mr. K. Ozaki and Mr. I. Hasegawa, whaling inspectors of the Japanese Government on the factory ship which operated in the Bonin waters. In the northern Pacific (pelagic), such observations were made by Fujino. We were not able, however, to send any biologist for a long period to any land stations, so we asked to the staff of the each land station to make such observation.

Analysing these data obtained, we classified at first the sei whales into two types based on the observation of the baleen plates, because this character was deemed as first essential, and then we investigated the extent of the ventral grooves. We rejected such data of the ventral grooves of whale which was not observed firstly by ourselves for identification of the two types according to baleen plate, in the course

of the analysing. We only used, therefore, such data of whales of which baleen plates were observed by ourselves and sametime the observation of the ventral grooves were available. Table 2 shows the number of sei whales on which the both observation were made.

As shown in tables 1 and 2, only 14 per cent of the total sei whales processed at the whaling land stations were observed on the both characters, while almost all sei whales were investigated in the Bonin Island waters and in the northern Pacific (pelagic).

Table 2. Number of Sei Whales of which Baleen Plates and the Extent of the Ventral Grooves were observed in 1952.

Geographical Areas	Males	Females	Total
Bonin Island (Pelagic)	268	139	407
Coastal	43	49	92
Northern Pacific (Pelagic)	8	6	14
Total	319	194	513

Baleen Plates

Omura, Nishimoto and Fujino (1952) describe that the baleen plates of sei whales taken in the Bonin Island waters are shorter in length, coarse in texture, greyish black in colour and with thick bristles as compared with those of ordinary sei whales. It was thought at that time that there might appear some intermediate type of baleen plates if we conduct further investigation in future. While investigating, however, the material of 1952, we could not find any of such intermediate type. All baleen plates were identified clearly as northern type (sei whale type) or southern type (bryde's whale type) without any exception. No hesitation was felt while identifying the both types.

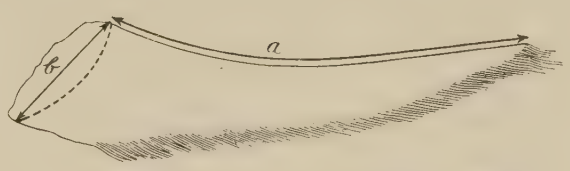

Fig. 1 Measurements of baleen plates. Dotted line shows the margin of gum.
a: length along the outer margin
b: breadth at base

The length and the breadth of each baleen plate was measured in centimeter. As shown in Fig. 1, the length was measured along the outer edge of the baleen plate from the point on the outer edge at the insertion to the gum to the tip of the plate, excluding the length of

the bristles. The breadth was measured by straight line between the two points on the outer and inner edge at the insertion to the gum.

The results of the measurements were dotted in Figs. 2 and 3, separately by sex.

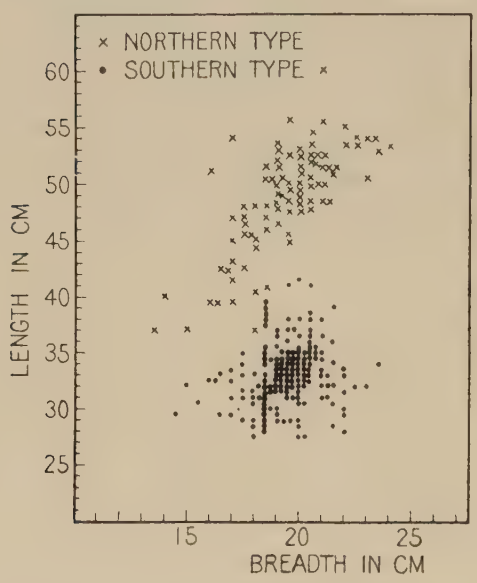

Fig. 2. Relation between length and breadth of baleen plates in sei whales. Males

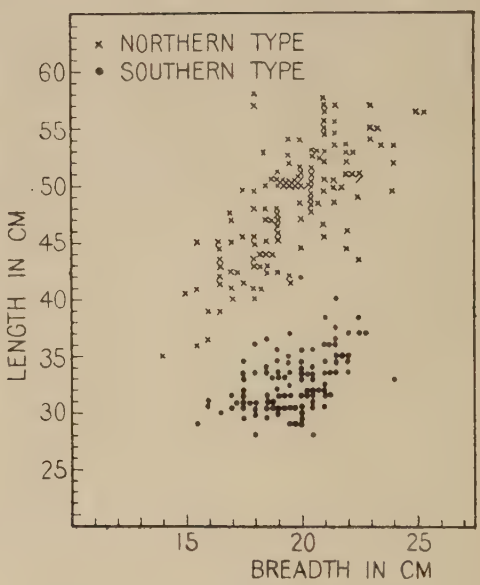

Fig. 3. Relation between length and breadth of baleen plates in sei whales. Females

As shown in these figures, the two types of northern and southern are almost completely separated into different groups in the shape of the baleen plates, both in males and females.

Then we calculated the quotient of the length divided by the breadth in each baleen plate. Table 3 shows the occurrence of each of such quotient (L/B). Figures 4 and 5 were drawn based on the data listed in table 3.

Judged from the above table and figures, the two types of northern and southern are also divided into two different groups nearly completely and we can say in general that the length of the baleen plate is over two times of its breadth in the northern type, while below two times in the southern type. No difference is seen between male and female.

Further, a difference is seen in the shape of the palate between northern and southern types.

As clearly shown in Figures 6 and 7, the breadth of the palate is

broad and slightly concaved inward in the middle part of it in the southern type, but the breadth is very narrow and convexed outward considerably in its posterior part in the northern type sei whale. This

Table 3. Quotient of Length/Breadth of Baleen Plates in Sei Whales.

L/B	Southern Type			Northern Type		
	Males	Females	Total	Males	Females	Total
1.20–1.29	1	0	1	0	0	0
1.30–1.39	6	2	8	0	0	0
1.40–1.49	9	6	15	0	0	0
1.50–1.59	24	22	46	0	0	0
1.60–1.69	43	30	73	0	0	0
1.70–1.79	40	24	64	0	0	0
1.80–1.89	18	13	31	0	0	0
1.90–1.99	11	7	18	0	1	1
2.00–2.09	10	1	11	1	3	4
2.10–2.19	4	1	5	0	5	5
2.20–2.29	0	0	0	6	14	20
2.30–2.39	0	0	0	13	29	42
2.40–2.49	0	0	0	22	17	39
2.50–2.59	0	0	0	21	30	51
2.60–2.69	0	0	0	17	22	39
2.70–2.79	0	0	0	8	11	19
2.80–2.89	0	0	0	4	2	6
2.90–2.99	0	0	0	0	3	3
3.00–3.09	0	0	0	1	0	1
3.10–3.19	0	0	0	3	2	5
3.20–3.29	0	0	0	0	1	1
Total Number	166	106	272	96	140	236
Geographical areas:—						
Bonin I.	164	101	265	0	0	0
Coastal	2	5	7	92	136	228
N. Pacific	0	0	0	4	4	8

difference is seemed a very essential external character beside others such as the baleen plate and the extent of the ventral grooves, and not the individual difference, though it is not recorded in quantities.

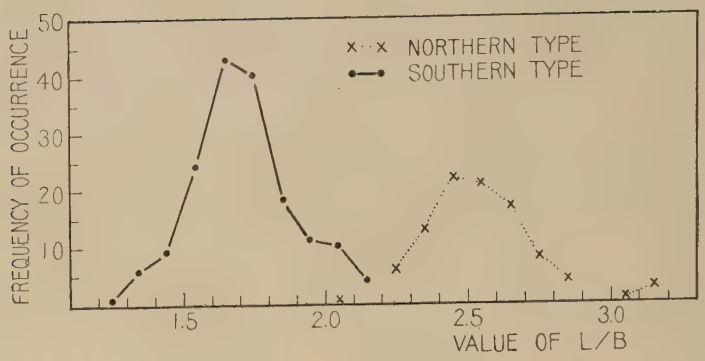

Fig. 4. Value of Length/Breadth of baleen plates in Sei whales. Males.

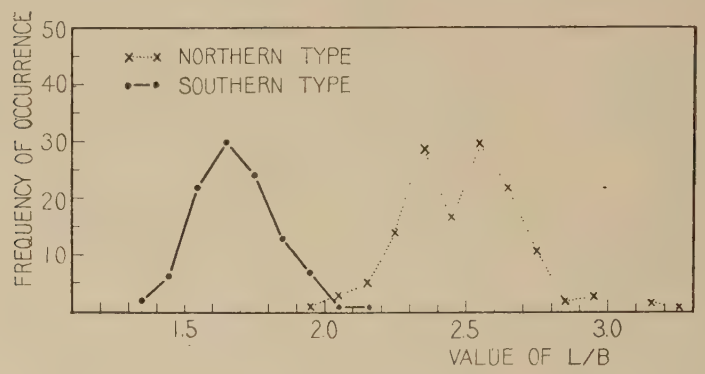

Fig. 5. Value of Length/Breadth of baleen plates in sei whales. Females.

Ventral Grooves

As already stated, we classified at first the sei whales taken in 1952 into two types according to their baleen plates and then we studied the extent of the ventral grooves, classifying in three groups. Table 4 shows its result.

According to table 4, the ventral grooves end anterior to umbilicus in all of the northern type sei whales and no exception is seen. The fact that the ventral grooves end anterior to umbilicus is one character of *Balaenoptera borealis* and our data well agree with those reported by Matthews (1938) concerning the sei whales in the southern hemisphere. Andrews (1916) describes, after investigating the sei whales of Japan, that the ventral furrows of *B. borealis* are present on the throat, breast and abdomen, but instead of extending posteriorly to the umbilicus,

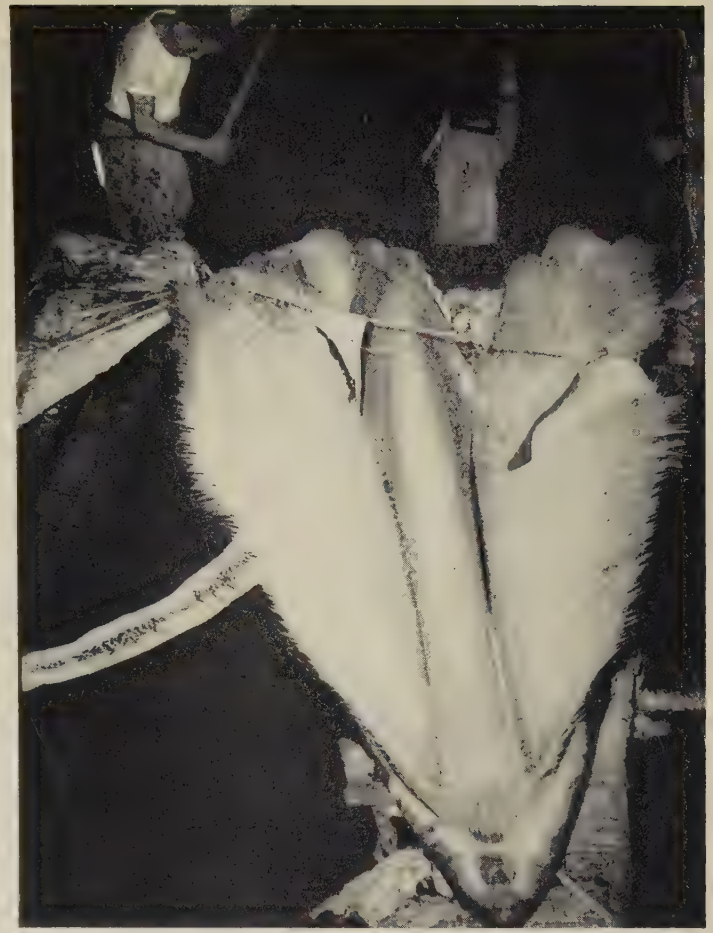

Fig. 7. Palate of a Sei Whale. Processed at Taiyo Ayukawa land station. Southern Type

Fig. 6. Palate of a sei whale. Processed at Taiyo Akkeshi land station. Northern Type

Table 4. Extent of Ventral Grooves in Sei Whales.

Extent of Ventral Grooves	Northern Type			Southern Type		
	Males	Females	Total	Males	Females	Total
Anterior to the Umbilicus	51	53	104	0	0	0
At the Umbilicus	0	0	0	4	0	4
Posterior to the Umbilicus	0	0	0	264	141	405
Geographical areas:—						
Bonin I.	0	0	0	268	139	407
Coastal	43	47	90	0	2	2
N. Pacific	8	6	14	0	0	0

they end half way between the tip of the pectoral fin laid back and the umbilicus. His observations were confirmed by our present data.

In the southern type sei whales, however, the ventral grooves run posteriorly beyond the umbilicus with only one per cent exceptions, in which the ventral grooves end at the umbilicus. No whale with its ventral grooves end anterior to the umbilicus is observed.

In table 5 of our former report (1952), such point is not so clear, because in that report the whales were only classified according to the geographical areas. When the whales were classified after the observation of their baleen plates, as mentioned above, the relation between the end of the ventral grooves and the umbilicus become so distinct. However, it is thought that there may be some exceptions, in which their ventral grooves end at the umbilicus, in the northern type sei whales in the future investigations as Matthews (1938) reports in the southern hemisphere.

Discussion

The so-called sei whales in the adjacent waters of Japan may be classified into two distinct types in the following three points, as mentioned already:

1. Quality and shape of the baleen plate and the thickness of its bristles
2. Shape of the palate.
3. Degree of the extent of the ventral grooves.

Besides, some differences are seen in the body proportions, as already stated in our former report (1952). However, in the body proportions except measurement No. 12 (Notch of flukes to end of system of ventral

grooves) there exist some individual differences, which make it difficult to identify the two types only by such body proportions. We can conclude that there are such differences between the two types only in group, not in individual. Measurement No. 12 is in other word the extent of the ventral grooves. So we conclude that the most distinct external characters in the two types are above mentioned three points.

Our osteological study has not been completed yet. However, it was made clear that there exist distinct differences in the external characters between the two types of so-called sei whales in the adjacent waters of Japan. And we consider at this stage of the investigation, the two types belong to the different species, and not to the different races in the species *B. borealis*.

The northern type sei whale is, as already stated, identical with *B. borealis*, but the characters of the southern type sei whale are well agree with those which hitherto reported as the identical characters of *B. brydei*. Olsen (1913) states many external characters of *B. brydei* but most important points distinguishing *B. brydei* from *B. borealis* are the extent of the ventral fullows and the character of the baleen, as already pointed out by Andrews (1916). The shape of the plate should be added to these two external characters.

In conclusion of the above statement, it might be concluded that the southern type sei whale is identical with *B. brydei*.

Concerning the osteology of *B. brydei*, the number of vertebrae is reported as 52–53 (Lönnberg 1931, Junge 1950). We examined the number of vertebrae of the both type sei whale in 1953, which is shown in Table 5.

The vertebral formula given by Andrews (1916) for *B. borealis* in the Japanese waters is C7+T14+L13+Ca23=57 and the total number of vertebrae given by Lönnberg for *B. borealis* is 56–57. Our data concerning the northern type sei whale agree with those statements, however, those concerning the southern type sei whale does not only agree with those figures, but also with the figures given by Lönnberg and Junge for *B. brydei*. According to our data the total number of vertebrae is 54–55 in the southern type sei whale, namely two more than those given by Lönnberg or Junge. However, Junge describes concerning the Pulu Sugi whale, from which his conclusion was drawn, that certainly one, perhaps two of the last caudals have been lost. So his figure of total number of vertebrae cannot be said as accurate. Future investigation on this point is needed for *B. brydei* in all areas concerned. The strong backward inclination of the spinous processes of the dorsal and

Table 5. Number of Vertebrae in Sei Whales of Japan.

Type	Whale No.	Body length	Sex	Date of catch	Position of Catch		Number of Vertebrae				
					N. Lat.	E. Long.	C.	T.	L.	Ca.	Total
	1)	ft.							3)		
S	T. 57	42	♂	7 Jul. '53	37°–41'	142°–28'	7	14	34*		55
〃	T. 60	44	♀	11 Jul. '53	36 –54	142 –31	7	14	34*		55
〃	T. 63	40	♂	13 Jul. '53	36 –50	142 –32	7	14	34*		55
〃	T. 64	41	♂	13 Jul. '53	36 –54	142 –33	7	14	34*		55
〃	T. 65	40	♂	13 Jul. '53	36 –52	142 –22	7	14	34*		55
〃	T. 66	37	♀	13 Jul. '53	36 –57	142 –25	7	14	33*		54
〃	T. 67	43	♂	13 Jul. '53	36 –50	142 –29	7	14	33*		54
〃	T. 70	43	♀	20 Jul. '53	36 –07	144 –20	7	14	34*		55
〃	T. 71	37	♀	20 Jul. '53	36 –06	144 –18	7	14	33*		54
〃	2) Ki. 32	35	♀	17 Aug. '53	38 –07	144 –00	7	14	14	19	54
〃	Ki. 33	42	♀	17 Aug. '53	37 –24	143 –18	7	14	14	20	55
〃	Ki. 34	41	♀	17 Aug. '53	37 –21	143 –15	7	14	13	21	55
〃	Ki. 35	40	♀	17 Aug. '53	37 –18	143 –18	7	14	13	20	54
N	T. 69	45	♀	16 Jul. '53	37 –54	145 –38	7	14	35*		56
〃	T. 75	47	♀	11 Aug. '53	38 –02	145 –32	7	14	14	21	56

Remarks. 1) T. .....Taiyo Ayukawa Land station.
2) Ki. .....Kinkai Ayukawa Land station.
3) * .....not distinguished into lumbar and caudal regions

lumbar vertebrae, an important difference which separate *B. brydei* from *B. borealis* according to Junge, is also seen in the southern type sei whale. Our osteological study on the southern type sei whale will be reported in detail in future when the work is completed.

Hitherto *B. brydei* has been reported to inhabit in a narrow area of waters around Cape of Good Hope. However, Kellogg (1931) describes that in the returns made by the Norwegian companies operating off Lower California 34 bryde's whales were caught in 1926. Junge (1950) notes that a whale cast ashore on the coast of Pulu Sugi, near Singapore, and *B. edeni*, as reported by Anderson (1878) are both identical with *B. brydei* and concluded further that this whale occurs in South African waters as well as in the waters of South-eastern Asia. Ruud (1952) reports that 42 sei whales taken in 1952 in the waters of French Equatorial Africa were all bryde's whale after investigating their baleen plates and he further states that we must assume that the bryde's whale has a much wider distribution than previously known and we may expect that this species can be met with in subtropical and tropical waters in all oceans.

In the waters near Japan the bryde's whale inhabit mostly in the Bonin waters. It migrates further north as far as off Sanriku (N-E part of Japan Proper) but we assume at the present stage of our investigation that it never go north beyond the polar front.

Regarding to the distribution of the sei and bryde's whales of Japan we found recently some unpublished data concerning the measurements of body proportions. These data were collected during the period from November 1935 to July 1936 at the various

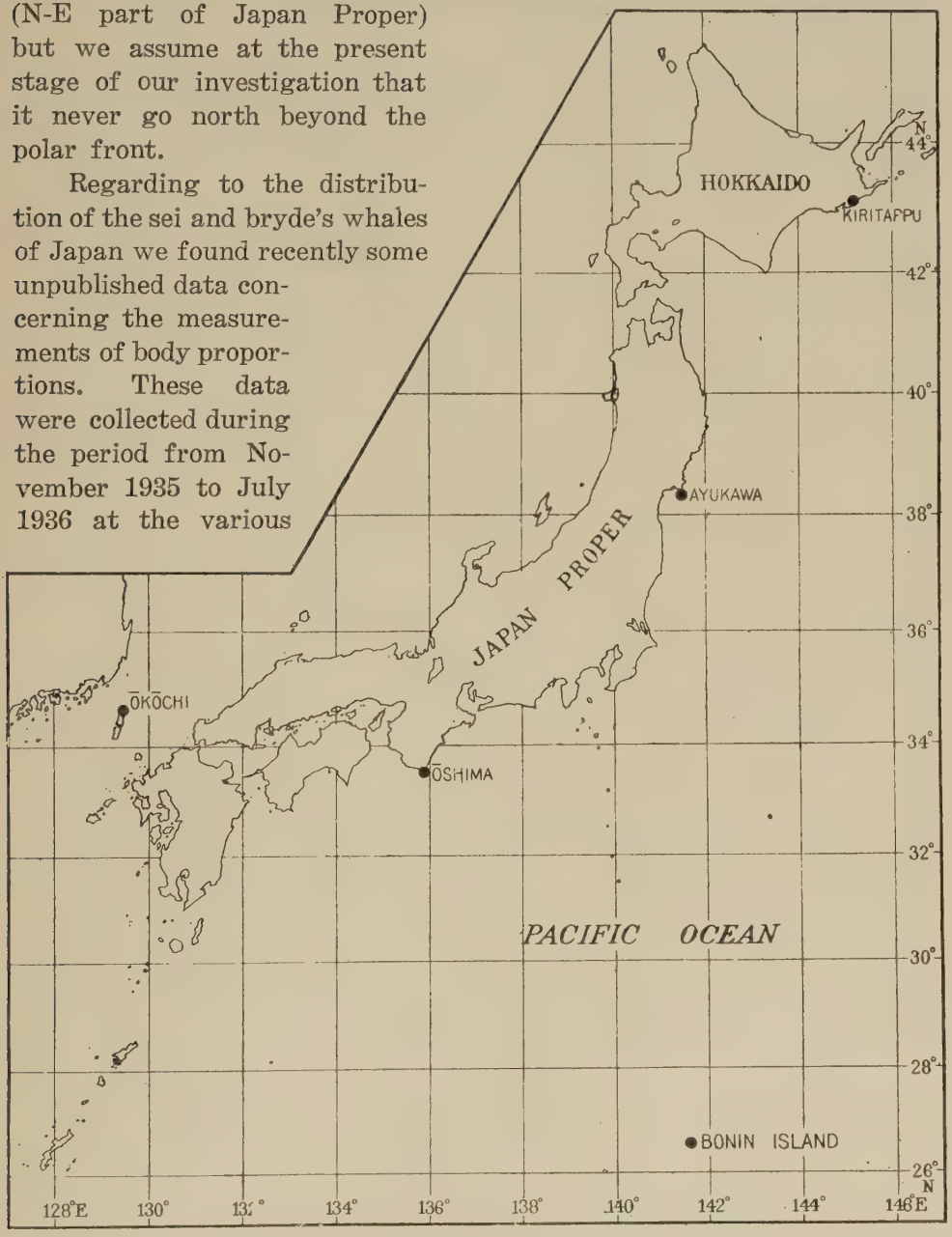

Fig. 8. Location of the Whaling land stations of Okochi, Oshima, Bonin Is., Ayukawa and Kiritappu.

land stations of Japan, of which location are shown in Fig. 8. Some body proportions of the socalled sei whales processed at these land stations were measured.

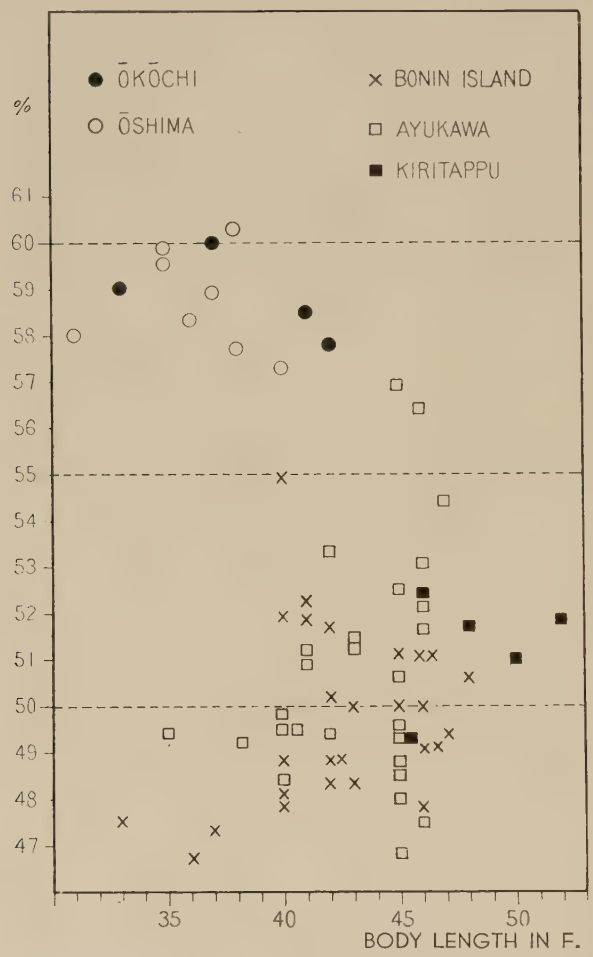

Fig. 9. From tip of lower jaw to posterior end of the system of ventral grooves (shown as percentages of body length)

Seven measurements were made to each sei whales processed, but most important one in this connection is the length from the tip of the lower jaw to the end of the system of the ventral grooves. Though the measurement cannot be said as accurate, because this was done by the staff of the each land stations, instead of the biologist, however, we can assume that these data are still available to get rough idea of the distribution of the both species.

In Fig. 9 the length from the tip of the lower jaw to the end of the system of the ventral grooves are shown in percentage against the total body length, separately according to each land station. We can see two groups in this figure, one being over 55–56 per cent and another one is below this figure. The former means the whales, of which ventral grooves extend posteriorly far beyond the middle of the body, which is one important character of the bryde's whale. The latter means that whale belongs the ordinal sei whale. All whales processed at Okochi and Oshima land stations belong to the bryde's whale and those processed at Bonin Island, Ayukawa, and Kiritappu land stations belong to the ordinal sei whales with some exceptions.

Andrews (1916) observed some sei whales at Oshima land station, but no record of measurements was given by him. So we cannot conclude which type of sei whale he observed there.

As shown in table 3 and 4, all sei whales taken in the Bonin waters belong to the southern type, namely *B. brydei*. Also in our former account (1952), all whales were southern type with a few exceptions. However, our present data show that all sei whales processed in 1935–36 belong to the northern type with only one exception, which we cannot conclude to which type it belongs.

How can be occur such difference? We should assume that is because the difference of the seasons. The seasons of the Bonin Island whaling in the post-war days are quite different as compared with those in the pre-war days. In the pre-war days the whaling was mainly operated in the period of January to April. In the post-war days the seasons were commenced later and later, and now it has been designated by the Japanese Government that no baleen whales should be taken prior 1st May. Consequently, now the season is quite different from that in the pre-war days.

Table 6. Monthly catch of Sei Whales in the Bonin Waters in the Seasons 1935–36 and 1952.

Months	1935–36 (N-Type)	1952 (S-Type)
Nov.	1	0
Dec.	1	0
Jan.	0	0
Feb.	2	0
Mar.	11	0
Apr.	12[1)]	0
May	0	235[2)]
Jun.	0	176

Notes: 1) Season closed on 8 Apr. 1936.
2) Season opened on 1 May 1952.

Table 6 shows the monthly catch in 1935–36 and 1952. The whaling was commenced from 1st May in 1952, but it was ended on 8th April in 1935–36.

Judged from the above fact, we assume that a herd of *B. borealis* comes near to Bonin Island in the period from December to the middle of April, and after the herd passed north another herd of *B. brydei* approaches to the island from the middle or end of April. This herd of *B. brydei* seems also go north towards the end of June as far as off Sanriku, but one part of that seems to remain longer in the Bonin waters. According to the Japanese Fisheries Agency (1953), a whale marking trip was conducted in the Bonin waters from 27th June to 10th July 1952 and 74 sei whales were sighted in this period.

As mentioned above, many *B. brydei* have been taken yearly in the seas around Bonin Island, but it is the fact in the post-war days. Namely, it can be said that it was made clear that a new herd of

B. brydei approaches to that island in the period in which hitherto no whaling had been conducted, and consequently a new whaling for this herd had inaugurated quite recently.

It is very interesting to investigate the ratio of intermingling of the both species in the waters off Sanriku, especially in connection with the oceanographic conditions of the sea water, because the two currents of warm and cold water intermingle in these areas of the sea. We collected some data in 1952, but it was so few to get any conclusion on this point, as shown in Fig. 10.

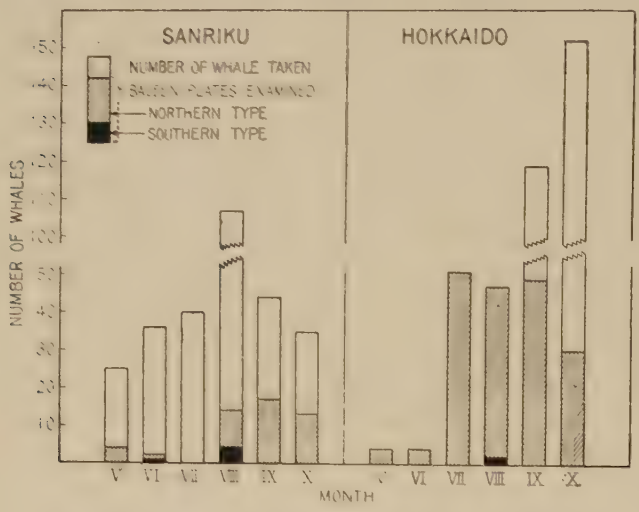

Fig. 10. Number of sei whales taken and number of baleen plates examined in 1952 in Sanriku and Hokkaido.

Many baleen plates have been sent to the laboratory in 1953. They are now under investigation and the result will be published later.

Conclusion

1. The two types of sei whales in the adjacent waters of Japan, as reported in our former account (1952), are separated clearly by the following characters.
   a. Quality and shape of the baleen plate and the thickness of its bristle.
   b. Shape of the palate.
   c. Degree of the extent of the ventral grooves.
2. Though the osteological study has not been completed yet, there are some differences between the two types in the total number of vertebrae, etc.
3. The conclusion from above is that we can consider the southern type and *B. brydei* conspecific and the northern type is identical with *B. borealis*.

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On the Serological Constitution of the Sperm- and Baired beaked-Whales (I) Blood Groups of the Sperm- and Baired beaked-Whales

By

Kazuo Fujino

Introduction

In the serological studies on whales, the author at first tried to classify the antigens contained in their erythrocytes. Consequently it was found that four and three kinds of blood group exist in the sei-, fin-, blue- and humpback-whales[1] belonging to the baleen whale and the dolphin[2] belonging to the toothed whale respectively. In the same manner as in the above stated cases the blood groups of the sperm whale (*Physeter catodon*) and the baired beaked whale (*Berardius bairdii*) were classified into six kinds as the combination of the two systems, namely Pc_1Pc_2 and Sp systems in the sperm and Br_1Br_2 and Pb systems in the baired beaked respectively.

The author should express his deep gratitude to Mr. Hasegawa, chief of the Ayukawa whaling land station of Taiyo Gyogyo Co. for his thoughtful help and Prof. Yasuo Suyehiro, Prof. Tanemoto Furuhata and Dr. Hideo Omura for their kind advices in carrying out this study.

Material and method

Erothrocytes of whale: The coastal whaling grounds are generally far off and it takes comparatively long time to tow the catches to the whaling land station. So the carcases are incised in the abdominal region to take away the blood for the purpose of keeping the meat fresh. By this reason it is difficult to collect the sera of whales. Whale erythrocytes were taken from the clots remaining in the heart and were cleaned with the physiological salt solution for the use of the immunization and the other reactions.

Immune animal: Domestic fowels were used as immune animal besides rabbits in the previous work, and prior to the immunization their serum-types were examined.

As regards human erythrocytes, immunization, antiserum, agglutination, hemolysis and adsorption test, materials and methods were just same as in the previous work.

Isohemagglutination and serum-type

As the sera of whales had not been collected, the isohemagglutination and serum-type of whales were not examined.

Antigens proved with immune antibodies

1. Immune antiserum against each antigen

(a) Anti-sperm-whale Pc_1- and Pc_2- sera: When a rabbit or fowl is immunized with the sperm whale erythrocytes which belong to Pc_1Sp-, the anti-Pc_1Sp- agglutinin and hemolysin are produced in the serum of the animal together with the species specific agglutinin and hemolysin against the sperm whale erythrocytes. When the species specific antibodies are adsorbed away from this serum with the Pc_2Sp- or Pc_2Sp- erythrocytes, the anti-Pc_1 immune agglutinin and hemolysin are obtained. The anti-Pc_2 immune agglutinin and hemolysin are obtained by the same operation. With these immune antibodies, it was proved that the existences of the agglutinogens and hemolysinogens, namely Pc_1 and Pc_2 in both, were perfectly consistent with each other. Consequently, the sperm whale blood was classified into three kinds, namely Pc_1Pc_2, Pc_1 and Pc_2 groups.

(b) Anti-sperm-whale Sp-ferum: When a rabbit is immunized with such the Pc_1Sp- erythrocytes as contains Sp antigen, the anti-Pc_1Sp- agglutinin and hemolysin are produced in the rabbit serum together with the species specific agglutinin and hemolysin against the sperm whale erythrocytes. If the species specific and the anti-Pc antibodies are adsorbed away from its serum with the Pc_1Sp- erythrocytes, the anti-Sp antibodiers are obtained. Instead of the Pc_1Sp+ and Pc_1Sp-, using the Pc_2Sp+ and Pc_2Sp- erythrocytes as antigens for immunization and adsorption respectively, the anti-Sp immune antibody may be also obtained. By this immune antibody the sperm whale blood was classified independently to the Pc_1Pc_2 system into two groups, namely $Sp+$ and $Sp-$: The former contains the Sp antigen and the latter doesn't contain it.

c) Anti-baired beaked whale Br_1- and Br_2- sera: By the same method as described in the section (a), the existences of the Br1 and Br2 antigens which are contained correlatively each other in the beaked whale red cells were confirmed by the immune agglutinin and hemolysin. Consequently the blood groups of the beaked whale were classified into three kinds, namely Br_1Br_2, Br_1 and Br_2 groups.

(d) Anti-baired beaked-whale Pb-serum: Methods in this section are just same as in the section (b). When an rabbit is immunized with the erythrocytes containing the Pb antigen, several kinds of antibodies are produced in the rabbit serum. If the anti-Br_1, Br_2 and the species specific antibodies are adsorbed away from those by erythrocytes in which Pb antigen is not contained, anti-Pb antibody is obtained. By this immune antibody the baired beaked whale bloods are classified independently to the Br_1Br_2 system, into the two groups, namely Pb+ and Pb−: The former contains Pb antigen and the latter doesn't.

2. Agglutinin titer and hemolysin titer

(a) Anti-sperm whale erythrocytes immune sera: Some examples of the agglutinin and hemolysin titer of the immune sera which is obtained by the said method are shown in the Tables I and II. It may be seen from these tables that the titer of the anti-Pc_1 antibody is lower in the case of using rabbit than fowl as immune animal. While it seems that the sensitivity in rabbit against Pc_2 is higher than that in fowl.

The titers of anti-Pc_2 antibodies which were produced in the rabbit serum by the four-time and seven-time (normal) immunization are shown in (b) of the Table I. It will be seen from the table that the titer of the anti-Pc_2 agglutinin already becomes up to 2,560 times after four-time immunization and reaches to such a high degree as 81,920 times by normal immunization. According to this fact, it seems to the author that the rabbit has a high sensitivity against Pc_2 antigen. As regards the difference between sensitivities of a rabbit against Pc_1 and those against Pc_2, it is to be shown in (c) and (f) of Table I that the anti-Pc_2 antibody reached to a the higher titer than the anti-Pc_1 antibody when the rabbit is immunized with the mixture of erythrocytes of Pc_1Sp- and Pc_2Sp-. It will be seen from this fact that the rabbit seems to be more sensitive to Pc_2 than to Pc_1.

In this experiment, for the purpose of comparison of the sensitivities against both antigens the erythrocytes which are used for the immune antigen should be made equivalently to the three individuals, in each type of Pc_1 and Pc_2, and their both types of the erythrocytes had to be mixed equally in quantity. And then their total quantity was put into the 10% suspension of the salt solution and was used for the immunization by the regular method. The titers of the anti-Sp antibodies are shown in the Table II.

(b) Anti-baired beaked whale erythrocytes immune sera: Each one example of the agglutinin titer of the anti-bodies, which are produced

Table I. Agglutinin titer and hemolysin titer of the anti-Pc_1 and Pc_2 immune sera

(a) Anti-Pc_1 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum type	A+ or A−		No.,	Blood-group	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240
No. 2 Pc_1Sp-	No. 26 Rabbit Female	o′	A−	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	+	−	−	−	−	−	−
					No. 3	Pc_1Sp-	##	##	##	+	−	−	−	−	−	−
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−
No. 2 Pc_1Sp-	No. 14 Fowl Female	o′		No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	##	##	##	+
					No. 3	Pc_1Sp-	##	##	##	##	##	##	##	##	##	+
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Pc_2 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum type	A+ or A−		No.,	Blood-group	1/320	1/640	1/1280	1/2560	1/5120	1/10240	1/20480	1/40960	1/81920	
No. 7 Pc_2Sp-	No. 23 Rabbit Female	α′	A−	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	+	+	−	−	−	−	−	
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	
					No. 9	Pc_2Sp-	##	##	##	+	−	−	−	−	−	
〃	〃	〃	〃	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	##	##	+	
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	
					No. 9	Pc_2Sp-	##	##	##	##	##	##	##	##	+	
〃	No. 15 Fowl Female	o′		No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	+	−	−	−	−	−	−	
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	
					No. 7	Pc_2Sp-	##	##	+	−	−	−	−	−	−	

* This was collected in the next day of 4th immunization, namely 8 days after 1st immunization.

** This was obtained by the normal immunization.

Table I (cont.)

(c) Agglutinin titers of the anti-Pc_1 and Pc_2 antibodies obtained by the simultaneous immunization.

Immune antigen	Immune animal: No., Sex	Immune animal: Serum-type	Immune animal: A+ or A−	Erythrocytes for adsorption	Erythrocytes for agglutination: No.,	Erythrocytes for agglutination: Blood-group	Dilution of antiserum: 1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240	1/20480	1/40960
Pc_1Sp- Nos. 1 2, 3 and Pc_2Sp- Nos. 7 9, 13	No. 27 Rabbit Female	o′	A+	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	+	−	−	−	−	−	−
					No. 3	Pc_1Sp-	##	##	+	−	−	−	−	−	−
					No. 7	Pc_2Sp-	−	−	−	−	−	−	−	−	−
				No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	#	#	+
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	##	##	##	##	##	##	##	#	+

(d) Anti-Pc_1 hemolysin titer

Immune antigen	Immune animal: No., Sex	Immune animal: Serum-type	Immune animal: A+ or A−	Erythrocytes for adsorption	Erythrocytes for hemolysis: No.,	Erythrocytes for hemolysis: Blood-group	Dilution of antiserum: 1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 2 Pc_1Sp-	No. 26 Rabbit Female	o′	A−	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	#	+	−	−	−	−	−	−
					No. 3	Pc_1Sp-	##	##	#	+	−	−	−	−	−	−
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−
No. 2 Pc_1Sp-	No. 14 Rabbit Female	o′		No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	#	#	+	−	−
					No. 3	Pc_1Sp-	##	##	##	##	##	##	#	+	−	−
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−

Table I (cont.)

(e) Anti-Pc_2 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A+ or A−		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 7 Pc_2Sp-	No. 23 Rabbit Female	α′	A−	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++++	++++	++++	+++	+	−	−	−	−	−
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	++++	++++	++++	+++	+	−	−	−	−	−
〃	〃	〃	〃	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++++	++++	++++	++++	++++	++++	++++	++++	+++	+
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	++++	++++	++++	++++	++++	++++	++++	++++	+++	+
〃	No. 15 Fowl Female	o′		No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++++	+++	+	−	−	−	−	−	−	−
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 7	Pc_2Sp-	++++	+++	+	−	−	−	−	−	−	−

(f) Hemolysin titer of the anti-Pc_1 and Pc_2 antibodies obtained by the simultaneous immunization

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A+ or A−		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
Pc_1Sp- Nos. 1,2,3 and Pc_2Sp- Nos. 7, 9, 13	No. 27 Rabbit Female	o′	A+	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	++++	++++	+++	+++	+	−	−	−	−	−
					No. 3	Pc_1Sp-	++++	++++	+++	+++	+	−	−	−	−	−
					No. 7	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−
				No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++++	++++	++++	++++	++++	++++	+++	+++	+	−
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	++++	++++	++++	++++	++++	++++	+++	+++	+	−

Table II Agglutinin titer and hemolysin titer of the anti-Sp immune serum

(a) Anti-Sp agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum-type	A_+ or A_-		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 5	No. 25			No. 3	No. 10	$Pc_1Pc_2Sp_+$	##	##	##	##	##	##	##	#	+	–
					No. 12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–	–	–	–	–
	Rabbit	α'	A_-		No. 5	Pc_1Sp_+	##	##	##	##	##	##	##	#	+	–
Pc_1Sp_+	Female			Pc_1Sp_-	No. 3	Pc_1Sp_-	–	–	–	–	–	–	–	–	–	–
					No. 8	Pc_2Sp_+	##	##	##	##	##	##	#	#	+	–
					No. 7	Pc_2Sp_-	–	–	–	–	–	–	–	–	–	–

(b) Anti-Sp hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 5	No. 25			No. 3	No. 11	$Pc_1Pc_2Sp_+$	##	##	##	#	#	+	–	–	–	–
					No. 12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–	–	–	–	–
	Rabbit	α'	A^-		No. 5	Pc_1Sp_+	##	##	#	#	#	+	–	–	–	–
Pc_1Sp_+	Female			Pc_1Sp_-	No. 3	Pc_1Sp_-	–	–	–	–	–	–	–	–	–	–
					No. 4	Pc_2Sp_+	##	##	##	#	#	+	–	–	–	–
					No. 13	Pc_2Sp_-	–	–	–	–	–	–	–	–	–	–

Table III Agglutinin titer and hemolysin titer of the anti-Br_1 and Br_2 immune sera

(a) Anti-Br_1 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum-type	A_+ or A_-		No.,	Blood-group	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240
No. 23	No. 24			No. 34	No. 29	$Br_1Br_2Pb_-$	##	##	##	##	##	+	−	−	−	−
	Rabbit	α'	A^+		No. 26	Br_1Pb_-	##	##	##	##	##	+	−	−	−	−
Br_1Pb_-	Male			Br_2Pb_-	No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Br_2 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Surum-type	A_+ or A_-		No.,	Blood-group	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240
No. 34	No. 22			No. 26	No. 29	$Br_1Br_2Pb_-$	##	##	##	##	##	##	##	##	+	−
	Rabbit	α'	A^+		No. 26	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
Br_2Pb_-	Female			Br_1Pb_-	No. 34	Br_2Pb_-	##	##	##	##	##	##	##	##	+	−

Table III (cont.)

(c) Anti-Br_1 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120
No. 23	No. 24			No. 34	No. 29	$Br_1Br_2Pb_-$	##	##	##	+	–	–	–	–	–	–
	Rabbit	α′	A^+		No. 26	Br_1Pb_-	##	##	##	+	–	–	–	–	–	–
Br_1Pb_-	Male			Br_2Pb_-	No. 34	Br_2Pb_-	–	–	–	–	–	–	–	–	–	–

(d) Anti-Br_2 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-tvpe	A^+ or A^-		No.,	Blood-group	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120
No. 34	No. 22			No. 27	No. 29	$Br_1Br_2Pb_-$	##	##	##	##	##	+	+	–	–	–
	Rabbit	α′	A^+		No. 27	Br_1Pb_-	–	–	–	–	–	–	–	–	–	–
Br_2Pb_-	Female			Br_1Pb_-	No. 34	Br_2Pb_-	##	##	##	##	##	+	–	–	–	–

Table IV Agglutinin titer and hemolysin titer of the anti-Pb immune serum

(a) Anti-Pb agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{40}$	$\frac{1}{80}$	$\frac{1}{160}$	$\frac{1}{320}$	$\frac{1}{640}$	$\frac{1}{1280}$	$\frac{1}{2560}$
No. 8	No. 28	α'	A^-	No. 34	No. 11	$Br_1Br_2Pb_+$	##	##	##	##	##	+	−	−	−	−
	Rabbit				No. 29	$Br_1Br_2Pb_-$	−	−	−	−	−	−	−	−	−	−
Br_2Pb_+	Female			Br_2Pb_-	No. 6	Br_1Pb_+	##	##	##	##	+	+	−	−	−	−
					No. 27	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
					No. 8	Br_2Pb_+	##	##	##	##	##	+	−	−	−	−
					No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Pb hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{40}$	$\frac{1}{80}$	$\frac{1}{160}$	$\frac{1}{320}$	$\frac{1}{640}$	$\frac{1}{1280}$	$\frac{1}{2560}$
No. 8	No. 28	α'	A^-	No. 34	No. 11	$Br_1Br_2Pb_+$	##	##	##	+	−	−	−	−	−	−
	Rabbit				No. 29	$Br_1Br_2Pb_-$	−	−	−	−	−	−	−	−	−	−
Br_2Pb_+	Female			Br_2Pb_-	No. 6	Br_1Pb_+	##	##	##	+	−	−	−	−	−	−
					No. 27	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
					No. 8	Br_2Pb_+	##	##	##	+	−	−	−	−	−	−
					No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

in the rabbit sera by immunization with each type of the beaked whale erythrocytes, are shown in the Tables III and IV.

It will be admitted from these tables that the rabbit is a little more sensitive to Br_1 than to Br_2, but the difference of the sensitivities is not so remarkable as in case of the two antigens of the sperm whale.

In case of the immunization by the antigens Br_1 and that by Br_2 fowls as immune animal fell into convulsions and gave up their breath. So the antisera of the fowls were not obtained. It seems to the author that the baired beaked whale erythrocytes are poisonous to the fowl.

As shown in the Table IV, titers of the anti-Pb antibodies are not so high.

3. Frequency of each type

The frequencies of the blood groups which belong to the Pc_1Pc_2 and Sp systems in the sperm whale and the Br_1Br_2 and Pb systems in the beaked whale is shown in the Tables V and VI. As the sampling of these materials were not carried out systematically, it would be expected in the future work to discuss the problems on the whale resources and habits.

The relationship between the foetal blood group [3]and its mother whale's one is shown in the Table VI. The blood group of the foetus was confirmed with not only the agglutination and hemolysis but also with the adsorption test of the antibodies by their erythrocytes.

The body length at the period of delivery of the beaked whale foetus has not been classified enough up to the present day. From these examples, however, it may be approved that the blood groups are already formed at the body length of 2.53 meters (8 ft. 3 inch.) in male baired beaked whale and 2.61 metres (8 ft. 7 inch.) in female.

Table V Frequency of the blood groups of the sperm whale caught in the adjacent waters of Japan, 1953

Sex \ Blood group	Pc_1Pc_2-type			Pc_1-type			Pc_2-type			Total		
	Sp_+	Sp_-	To.	Sp_+	Sp_-	To.	Sp_+	Sp_-	To.	Sp_+	Sp_-	To.
Male	2	1	3	0	4	4	2	1	3	4	6	10
	(20.0)	(10.0)	(30.0)	(0.0)	(40.0)	(40.0)	(20.0)	(10.0)	(30.0)	(40.0)	(60.0)	(100.0%)
Female	3	2	5	3	2	5	2	4	6	8	8	16
	(18.8)	(12.5)	(31.3)	(18.8)	(12.5)	(31.3)	(12.5)	(24.9)	(37.4)	(50.0)	(50.0)	(100.0%)
Total	5	3	8	3	6	9	4	5	9	12	14	26
	(19.3)	(11.5)	(30.8)	(11.5)	(23.1)	(34.6)	(15.3)	(19.3)	(34.6)	(46.1)	(53.9)	(100.0%)

Table VI Frequency of the blood groups of the baired beaked whale

(a) Catch off Ayukawa, Miyagi Prefecture in 1951. The classification of Pb system had not been performed yet.

Sex \ Blood group	Br_1Br_2-type	Br_1-type	Br_2-type	Total
Male	2	3	2	7
	(28.6)	(42.8)	(28.6)	(100.0%)
Female	1	2	1	4
	(25.0)	(50.0)	(25.0)	(100.0%)
Total	3	5	3	11
	(27.3)	(45.4)	(27.3)	(100.0%)

Table VI (cont.)

(b) Catch off Ayukawa, Miyagi Prefecture in 1953

Blood group / Sex	Br_1Br_2-type			Br_1-type			Br_2-type			Total		
	Pb_+	Pb_-	To.	Pb_+	Pb_-	To.	Pb_+	Pb_-	To.	Pb_+	Pb_-	To.
Male	1	1	2	2	27	29	1	0	1	4	28	32
	(3.1)	(3.1)	(6.2)	(6.2)	(84.5)	(90.7)	(3.1)	(0.0)	(3.1)	(12.5)	(87.5)	(100.0%)
Female	0	0	0	0	7	7	0	1	1	0	8	8
	(0.0)	(0.0)	(0.0)	(0.0)	(87.5)	(87.5)	(0.0)	(12.5)	(12.5)	(0.0)	(100.0)	(100.0%)
Total	1	1	2	2	34	36	1	1	2	4	36	40
	(2.5)	(2.5)	(5.0)	(5.0)	(85.0)	(90.0)	(2.5)	(2.5)	(5.0)	(10.0)	(90.0)	(100.0%)

(c) Blood groups of the foetus

Mother Whale				Foetus		
No.	Date, caught	Body length in ft.	Blood group	Body length in m.	Sex	Blood groups
7	July 14, '53	37	Br_1Pb_-	2.53	male	Br_1Pb_-
38	Aug. 6, '53	36	Br_1Pb_-	2.61	female	Br_1Pb_-

Anti-Sp Heterohemagglutinin proved in the sei-whale normal serum

Heterohemagglutinin against the Sp antigen was found in the serum of No. 91 northern type sei-whale [1](42 ft. long, male) having been caught in the northern Pacific Ocean, in 1953. The hemagglutination and adsorption tests by sperm whale erythrocytes are shown in the Tables VII and VIII. It may be admitted from this table that this agglutinin is completely adsorbed away by the Sp type cells in no connection with the Pc_1Pc_2 system and is confirmed to be anti-Sp agglutinin. Its titer was about 8 or 16 times.

Table VII Agglutination of the anti-Sp agglutinin which was found in the No. 91 northern type sei-whale's serum against the each type of the sperm whale erythrocytes

Sperm whale erythrocytes		Dilution of the sei-whale serum							
No.	Blood group	1/1	1/2	1/4	1/8	1/16	1/32	1/64	1/128
10	$Pc_1Pc_2Sp_+$	##	##	#	+	+	–	–	–
12	$Pc_1Pc_2Sp_-$	+	–	–	–	–	–	–	–
5	Pc_1Sp_+	#	##	#	+	–	–	–	–
3	Pc_1Sp_-	+	–	–	–	–	–	–	–
4	Pc_2Sp_+	#	##	#	+	–	–	–	–
13	Pc_2Sp_-	+	–	–	–	–	–	–	–

Table VIII Adsorption test of the anti-Sp agglutinin which was found in the No. 91 northern type sei-whale's serum by the each type of the sperm whale erythrocytes

Sperm whale erythrocytes for adsorption	Sperm whale erythrocytes for agglutination		Dilution of the sei whale serum					
			1/1	1/2	1/4	1/8	1/16	1/32
No. 12	10	$Pc_1Pc_2Sp_+$	##	##	#	+	+	–
	12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–
$Pc_1Pc_2Sp_-$	5	Pc_1Sp_+	#	##	#	+	–	–
	3	Pc_1Sp_-	–	–	–	–	–	–
	4	Pc_2Sp_+	#	##	#	+	–	–
	13	Pc_2Sp_-	–	–	–	–	–	–

Table VIII (cont.)

Sperm whale erythrocytes for adsorption	Sperm whale erythrocytes for agglutination		Dilution of the sei whale serum					
			1/1	1/2	1/4	1/8	1/16	1/32
No. 3	10	$Pc_1Pc_2Sp_+$	##	##	#	+	+	–
	12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–
Pc_1Sp_-	5	Pc_1Sp_+	#	##	#	+	–	–
	3	Pc_1Sp_-	–	–	–	–	–	–
	4	Pc_2Sp_+	#	##	#	+	–	–
	13	Pc_2Sp_-	–	–	–	–	–	–
No. 13	10	$Pc_1Pc_2Sp_+$	##	##	#	+	+	–
	12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–
Pc_2Sp_-	5	Pc_1Sp_+	#	##	#	+	–	–
	3	Pc_1Sp_-	–	–	–	–	–	–
	4	Pc_2Sp_+	#	##	#	+	–	–
	13	Pc_2Sp_-	–	–	–	–	–	–
No. 10	10	$Pc_1Pc_2Sp_+$	–	–	–	–	–	–
	12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–
$Pc_1Pc_2Sp_+$	5	Pc_1Sp_+	–	–	–	–	–	–
	3	Pc_1Sp_-	–	–	–	–	–	–
	4	Pc_2Sp_+	–	–	–	–	–	–
	13	Pc_2Sp_-	–	–	–	–	–	–
No. 5	10	$Pc_1Pc_2Sp_+$	–	–	–	–	–	–
	12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–
Pc_1Sp_+	5	Pc_1Sp_+	–	–	–	–	–	–
	3	Pc_1Sp_-	–	–	–	–	–	–
	4	Pc_2Sp_+	–	–	–	–	–	–
	13	Pc_2Sp_-	–	–	–	–	–	–
No. 4	10	$Pc_1Pc_2Sp_+$	–	–	–	–	–	–
	12	$Pc_1Pc_2Sp_-$	–	–	–	–	–	–
Pc_2Sp_+	5	Pc_1Sp_+	–	–	–	–	–	–
	3	Pc_1Sp_-	–	–	–	–	–	–
	4	Pc_2Sp_+	–	–	–	–	–	–
	13	Pc_2Sp_-	–	–	–	–	–	–

Conclusion

1. (a) The existence of the two kinds of antigens and one antigen, which were found independently each other in the sperm whale erythrocytes, was affirmed positively by the immune antibodies obtained by

the immunization on rabbits or the domestic fowls with sperm whale red cells. In consequence, the sperm whale bloods were classified into six groups, namely Pc_1Pc_2SP+, Pc_1Pc_2Sp-, Pc_1SP+, Pc_1Sp-, Pc_2SP+ and Pc_2Sp-.

(b) By the same manner as stated on sperm whale, baired beaked whale blood was classified into six groups, namely Br_1Br_2Pb+, Br_1Br_2Pb-, Br_1Pb+, Br_1Pb-, Br_2Pb+ and Br_2Pb-.

2. (a) The frequency of blood groups of sperm whales caught in the adjacent waters of Japan is as follows:

Pc_1Pc_2Sp+:	19.3%	Pc_1Sp+:	11.5%	Pc_2Sp+:	15.3%
Pc_1Pc_2Sp-:	11.5%	Pc_1Sp-:	23.1%	Pc_2Sp-:	19.3%

(b) The frequency of blood groups of baired beaked whales caught off Ayukawa, Miyagi Prefecture, is as follows:

Br_1Br_2Pb+:	2.5%	Br_1Pb+:	5.0%	Br_2Pb+:	2.5%
Br_1Br_2Pb-:	2.5%	Br_1Pb-:	85.0%	Br_2Pb-:	2.5%

3. Two examples of blood groups of the baired beaked whale foetus were examined. Their blood groups were already formed at the body length of 2.53 meters in one male and at 2.61 metres in one female and were just same as their mother whales' blood group, namely Br_1Pb- type.

4. Heterohemagglutinin against the Sp antigen of the sperm whale red cells was recognized in the serum of the No. 91 northern type sei whale caught in the northern Pacific Ocean in 1953. Its agglutinin titer was about 8 or 16 times.

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On the Body Proportions of the Fin Whales (*Balaenoptera physalus* (L)) caught in the northern Pacific Ocean (I)

(Preliminary Report)

By

Kazuo Fujino

Introduction

As regards the fin whale population Y. Matsuura and K. Maeda (1942) deduced that the northern Pacific and the Antarctic fin whales belong to the different populations by the studies on the following items: (1) body length frequencies of the catch, (2) body proportions, (3) average body length at which sexual maturity is attained, (4) food habits and (5) diatom film infection. However, the reliable results of this has not been reached yet.

H. Omura stated (1950) that the fin whales in the adjacent waters of Japan may be distinguished into two populations, namely the west side's (Japan sea) and the east side's (Pacific Ocean) one, and that the American coastal and the Japanese coastal fin whales migrate northward through the Bering Strait and may reach convergently to the Arctic Ocean. The same results as the above were attained by the H. Kasahara's deduction also.

The author took up the "Body proportions" as a method of investigation on the fin whale races, and has been studying the materials obtained in the northern Pacific and the adjacent waters of Japan so far. The results hitherto obtained are stated in the present account as a preliminary report from which some ideas to the future investigation will be drawn.

Acknowledgements are due to the whaling inspectors of the Fisheries Agency of the Japanese Government, including Mr. Haruyuki Sakiura and Mr. Yoshiro Teraoka who kindly carried out a part of the measurements and also due to Dr. Hideo Omura who guided this study. The author further extends his deep gratitude to the members of the whaling land stations and to the crews on board the whaling factory ship "Baikal-Maru" for their kind help at the time of the measurement.

Material and method

The series of measurements is based upon that used by N. A. Mac-

kintosh and J. F. G. Wheeler (1929) for the blue and fin whales in the southern hemisphere.

The body proportions are expressed as the percentages of the total length, and in studying the differences in the various areas it was also considered whether the proportions of some parts varies according to body length or to the number of corpora lutea. The number of material examined is shown in Table I.

Table I. Number of fin whales on which the measurements of body proportions were made

Measurement No.	Body parts, examined	Japanese coastal		northern Pacific		Antarctic*	
		male	female	male	female	male	female
1	Total length	15	22	35	25	192	134
3	Tip of snout to blow-hole	15	22	35	24	172	118
4	Tip of snout to angle of gape	8	2	0	0	114	74
5	Tip of snout to centre of eye	14	22	35	25	192	134
6	Tip of snout to tip of flipper	13	22	31	22	158	113
7	Centre of eye to centre of ear	13	21	35	25	173	113
8	Notch of flukes to posterior emargination of dorsal fin	14	20	33	23	148	94
10	Notch of flukes to centre of anus	15	21	35	25	189	131
11	Notch of flukes to umbilicus	15	20	30	20	178	129
12	Notch of flukes to end of system of ventral grooves	13	20	34	25	132	81
13	Centre of anus to centre of reproductive aperture	15	21	35	25	185	117
14	Vertical height of dorsal fin	14	20	32	22	150	99
15	Length of base of dorsal fin	15	20	25	15	153	98
16	Axilla to tip of flipper	11	21	0	0	169	114
17	Anterior end of lower border to tip of flipper	14	21	34	25	122	73
19	Greatest width of flipper	14	21	35	24	124	78
20	Length of severed head from condyle to tip	0	0	5	6	135	88
21	Greatest width of skull	14	20	25	15	128	74
22	Skull length, condyle to tip of premaxilla	14	20	25	15	0	0

* Cited from Discovery Reports Vol. I, 1929.

From the results of the general biological investigation and the frequency of the occurence of the different blood groups, it may be considered that the stock of fin whales in the northern Pacific is consisted by some different populations. Furthermore the whaling grounds in 1941 and 1952 are different from each other. By these reasons the comparison was made between those in these different years firstly and then between

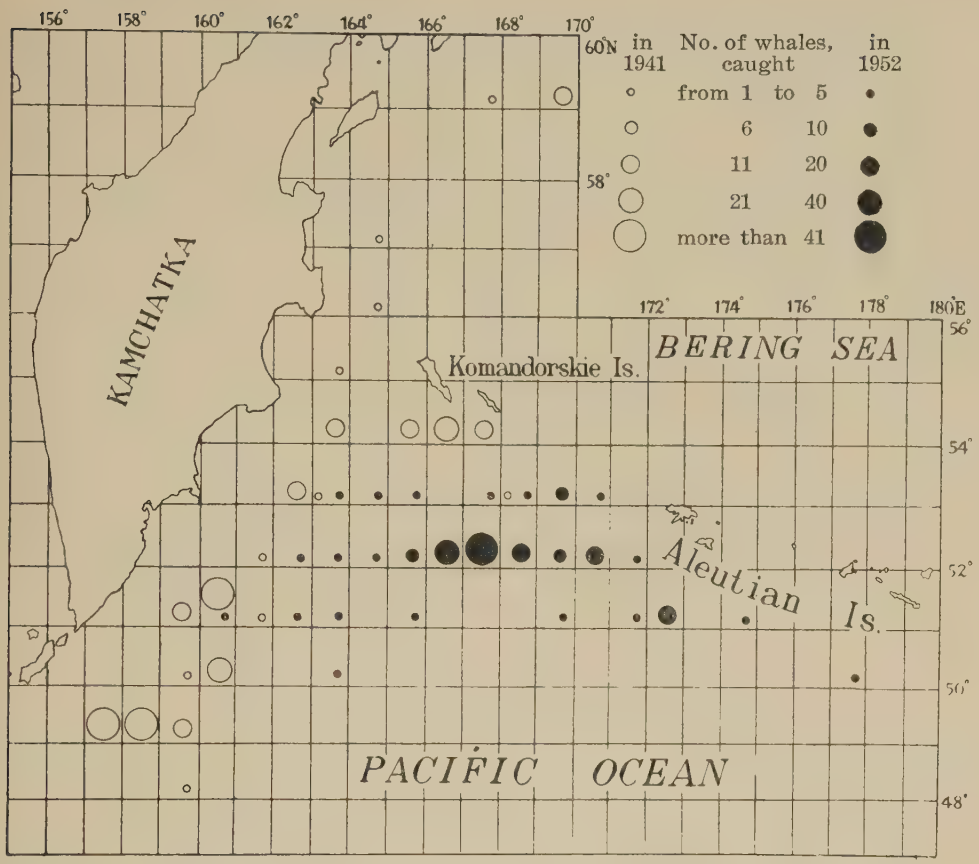

Fig. I. Northern Pacific whaling grounds in the years 1941 and 1952 (Fin whale).

those in the northern Pacific and in the Japanese coastal waters (east side of Japan) or in the Antarctic, based upon the data given by Mackintosh and Wheeler.

As shown in the Figure II these materials are not only rather scanty comparing with the total catch, but also cannot be said as representative sample. However still I consider the results of this study may give some light for the study of the population or communities in this species of whale.

Body proportions

(I) Comparison between the northern Pacific fin whales caught in 1941 and 1952: 10 males and 10 females in 1941 and 25 males and 15 females

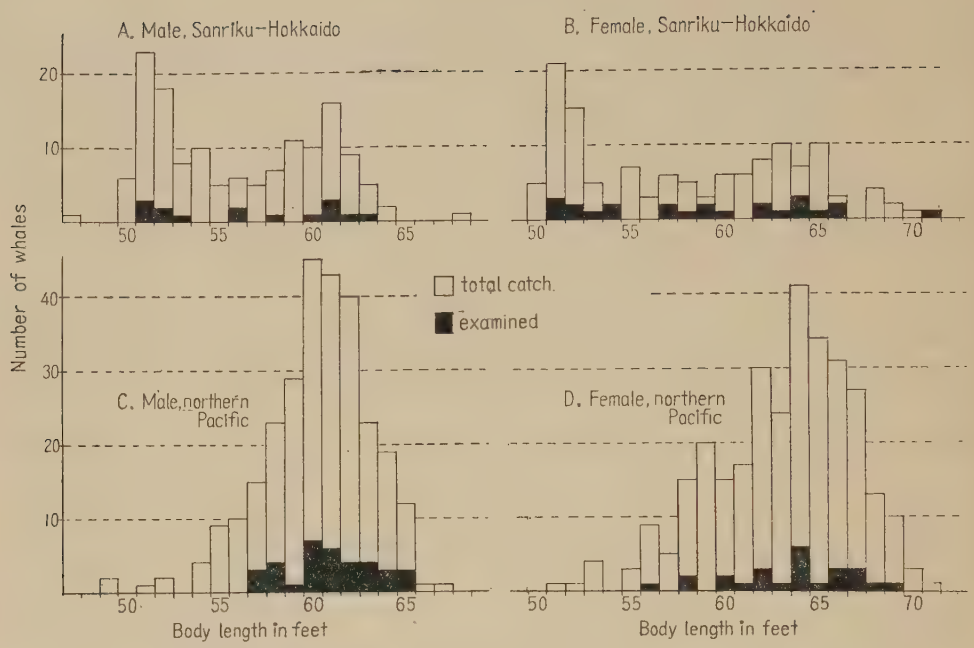

Fig. II. Fin whale. Total number of catch and the number examined according to body length in different areas in 1950.

in 1952 were examined The comparison of these are shown separately by the body length groups in the Table II.

Measurement nos. 3 and 20 (or 22) which represent the head proportion increase at first with the growth of body and reach to the maximum at a definite body length and after that body length is attained they show the tendency to decrease. On the nos. 8 and 10 which represent the posterior part of the body decrease according to the growth but this trend ceases at a body length at which the proportion of nos. 3 and 20 (or 22) reach their maximum. This body length is about 18 or 19 metres. No difference of the variation of proportion was seen between those measured in 1941 and 1952 concerning the points above mentioned. In other items representing the head or posterior regions any remarkable differences were also not recognized.

No whale in which the ventral grooves end anterior to the umbilicus was reported in 1941, but in 1952 6 males and 4 females among 25 and 15 males and females, respectively were found as such, and in the most remarkable case (60 ft. male whale No. 261) the distance from the end of ventral grooves to the umbilicus reached to 70 cm. (3.9% of body length).

Table II. Comparison of the body proportions of the northern Pacific fin whales taken in the years 1941 and 1952

A. Males

3. Tip of snout to blow-hole

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
16.5						1		1
17.0		1		1		1		1
17.5	1		1	2	1	1	1	3
18.0		2		2	1	1	2	4
18.5	1	1		2	2	2	1	5
19.0			1	1		4	2	6
19.5						1	2	3
20.0		1		1	1			1
20.5					1			1
21.0		1		1				
Total	2	6	2	10	6	11	8	25
Mean Value	18.0	18.8	18.3	18.50	18.8	18.3	18.6	18.56
Stand. Devi.				1.16				0.93

B. Females

3. Tip of snout to blow-hole

Range of Values	1941					1954				
	17	18	19	20	To.	17	18	19	20	To.
17.5						1		2	1	4
18.0	1				1					
18.5		1		1	2	1		2	2	5
19.0		1		1	2		1	2		3
19.5			2	1	3		2			2
20.0									1	1
20.5				1	1					
Total	1	2	2	4	9	2	3	6	4	15
Mean Value	18.0	18.8	19.5	19.4	19.11	18.0	19.3	18.3	18.6	18.56
Stand. Devi.					0.70					0.77

5. Tip of snout to centre of eye

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
19.0					1			1
19.5	1	1	1	3		4	1	5
20.0	1	2		3			1	1
20.5		1		1	2		2	4
21.0						2	2	4
21.5		2	1	3	1	3	1	5
22.0						2	1	3
22.5					2			2
Total	2	6	2	10	6	11	8	25
Mean Value	19.8	20.5	20.5	20.35	21.1	20.8	20.8	20.84
Stand. Devi.				0.81				1.01

B. Females

5. Tip of snout to centre of eye

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
19.5						1				1
20.0										
20.5	1	2	1	2	6			1		1
21.0		1		1	2	1		2	2	5
21.5				1	1		2	2	1	5
22.0			1		1		1		1	2
22.5										
23.0								1		1
Total	1	3	2	4	10	2	3	6	4	15
Mean Value	20.5	20.7	21.3	20.9	20.85	20.3	21.7	21.4	21.4	21.30
Stand. Devi.					0.50					0.75

(II) Comparison between the northern Pacific and the Japanese coastal fin whales: As stated above no difference was recognized between the proportions of the northern Pacific fin whales in 1941 and 1952, so both of them were brought together and were compared with those in the Japanese coastal waters. The comparison of both areas are shown separately according to the body length in Table III.

Table II. (cont.)

A. Males

6. Tip of snout to tip of flipper

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
39						1		1
40					2	1	1	4
41						4	1	5
42	1	2	1	4	1	1	1	3
43		2		2	1	1	2	4
44					2	2	1	5
45							2	2
46		1		1				
Total	1	5	1	7	6	10	8	24
Mean Value	42.0	43.2	42.0	42.86	42.2	41.6	42.9	42.17
Stand. Devi.				1.36				1.72

B. Females

6. Tip of snout to tip of flipper

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
39									1	1
40			1		1		2			2
41		1		2	3		1	2		3
42	1	1			2	1		3	2	6
43				1	1	1			1	2
44								1		1
Total	1	2	1	3	7	2	3	6	4	15
Mean Value	42.0	41.5	40.0	41.7	41.43	42.5	40.3	42.0	41.5	41.60
Stand. Devi.					0.91					1.25

7. Centre of ear to centre of eye

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
3.5						1		1
4.0			1	1		6	7	13
4.5	2	4	1	7	6	4		10
5.0		1		1				
5.5							1	1
6.0								
6.5		1		1				
Total	2	6	2	10	6	11	8	25
Mean Value	4.5	4.9	4.3	4.70	4.5	4.1	4.2	4.24
Stand. Devi.				0.64				0.38

7. Centre of ear to centre of eye

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
3.5									1	1
4.0		1		1	2		2	6	2	10
4.5	1	2	2	2	7	2	1		1	4
5.0				1	1					
Total	1	3	2	4	10	2	3	6	4	15
Mean Value	4.5	4.3	4.5	4.5	4.45	4.5	4.2	4.0	4.0	4.10
Stand. Devi.					0.27					0.27

To clarify the relation between the proportions y of various parts and the body length x, the correlation coefficients r were calculated by the following formula:

$$r=\frac{1}{n}\cdot\frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sigma_x\,\sigma_y}\ , \qquad 1\geqq|r| \qquad (I)$$

where σ_x and σ_y denote the variances of x and y respectively. In Table IV the correlation coefficients of various items are shown, calculated by

Table II. (cont.)

A. Males

8. Notch of flukes to post. emarg. of dorsal fin

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
20.0							1	1
20.5					1		1	2
21.0						1		1
21.5		1	1	2		4	3	7
22.0		1		1	1	3		4
22.5		1		1	2	1	1	4
23.0	1			1	1	1		2
23.5	1			1		1	1	2
24.0		1		1	1		1	2
24.5		1		1				
Total	2	5	1	8	6	11	8	25
Mean Value	23.3	22.9	21.5	22.81	22.4	22.0	21.9	22.60
Stand. Devi.				1.06				0.85

B. Females

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
21.0								1		1
21.5			1	2	3		1	2		3
22.0							1	2	1	4
22.5				1	1	1			1	2
23.0		1			1		1		1	2
23.5		1			1	1		1		2
24.0									1	1
24.5										
25.0		1	1		2					
Total	0	3	2	3	8	2	3	6	4	15
Mean Value	—	23.8	23.3	21.8	22.93	23.0	22.2	21.9	22.9	22.37
Stand. Devi.					1.38					0.85

10. Notch of flukes to centre of anus

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
25.0					1			1
25.5								
26.0							1	1
26.5			1	1	2	1	2	5
27.0		1		1	2	1	2	5
27.5		1		1		5	1	6
28.0	1	2		3		2	1	3
28.5		1		1	1	1		2
29.0							1	1
29.5	1	1	1	3				
30.0						1		1
Total	2	6	2	10	6	11	8	25
Mean Value	28.8	28.1	28.0	28.20	26.8	27.8	27.2	27.34
Stand. Devi.				1.00				1.00

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
25.5								2		2
26.0								1		1
26.5							1	2		3
27.0				1	1					
27.5			1	1	2		1		4	5
28.0				1	1	1	1	1		3
28.5										
29.0		2	1		3	1				1
29.5										
30.0		1			1					
30.5	1			1	2					
Total	1	3	2	4	10	2	3	6	4	15
Mean Value	30.0	28.8	27.8	27.8	28.80	28.0	26.8	25.8	27.0	27.14
Stand. Devi.					1.21					0.98

the formula I. It may be seen from this table that nos. 3, 5, 8, 10 and 22 of Japanese coastal whales are closely related with their body length, because the absolute values of their coefficients are more than

Table II. (cont.)

A. Males B. Females

11. Notch of flukes to umbilicus

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
42							1	1
43						2	2	4
44					3	1	3	7
45		1	1	2	2	4		6
46		1		1		2	2	4
47			1	1	1	1		2
48	1			1		1		1
Total	1	2	2	5	6	11	8	25
Mean Value	48.0	45.5	46.0	46.20	44.8	45.2	44.0	44.72
Stand. Devi.				1.17				1.42

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
41								2		2
42								1		1
43								1		1
44						1	1	1	2	5
45			1	1	2	1	2		1	4
46								1	1	2
47	1	2			3					
Total	1	2	1	1	5	2	3	6	4	15
Mean Value	47.0	47.0	45.0	45.0	46.20	44.5	44.7	42.8	44.8	43.93
Stand. Devi.					0.98					1.51

12. Notch of flukes to dost. end of vent. grooves

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
41					1			1
42		3		3	1		1	2
43						1	3	4
44			1	1	2	2	1	5
45		2		2		5	1	6
46	2			2	1		1	2
47			1	1	1	1	1	3
48						2		2
Total	2	5	2	9	6	11	8	25
Mean Value	46.0	43.2	45.5	44.33	44.0	45.4	44.1	44.64
Stand. Devi.				1.83				1.83

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
41				2	2			2		2
42				1	1			2		2
43			1	1	2	1				1
44			1		1	1	2	1	1	5
45	1				1			1	2	3
46		2			2		1		1	2
47										
48		1			1					
Total	1	3	2	4	10	2	3	6	4	15
Mean Value	45.0	46.7	43.5	41.8	43.93	43.5	44.7	42.5	45.0	43.73
Stand. Devi.					2.21					1.57

0.5. In other words, the positive correlations in the nos. 3, 5 and 22 and the negative one in the nos. 8 and 10 are seen with the growth of the body. In other measurements, namely nos. 6, 7, 13, 14, 15, 17 and 19, the correlation with the body length is seemed rather little.

As regards the northern Pacific fin whales the absolute values of the coefficients are less than 0.5 and little correlation with the body length are recognized in nos. 3, 5, 8, 10 and 22. Besides the same tendency is also seen on the measurements in which a little correlation

Table II. (cont.)

A. Males

ange of alues	1941				1952			
	17	18	19	To.	17	18	19	To.
5.5		1		1			2	2
6.0		1		1	2	5		7
6.5		1		1	1	3	5	9
7.0		3	1	4	2	2	1	5
7.5	1			1	1	1		2
8.0			1	1				
8.5	1			1				
otal	2	6	2	10	6	11	8	25
lean alue	8.0	6.5	7.5	7.00	6.7	6.5	6.3	6.46
tand. evi.				0.84				0.53

B. Females

13. Centre of anus to centre of repr. aperture

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
2.0				2	2	1				1
2.5	1			1	2		1	2		3
3.0		2	1	1	4	1	2	3	4	10
3.5		1	1		2					
4.0								1		1
Total	1	3	2	4	10	2	3	6	4	15
Mean Value	2.5	3.2	3.3	2.4	2.80	2.5	2.8	3.0	3.0	2.90
Stand. Devi.					0.51					0.42

14. Vertical height of dorsal fin

ange of alues	1941				1952			
	17	18	19	To.	17	18	19	To.
1.6			1	1	1			1
1.8	1	1		2			1	1
2.0					1	3	4	8
2.2		1		1	3	4	2	9
2.4		1		1		3		3
2.6	1	1		2		1	1	2
2.8					1			1
otal	2	4	1	7	6	11	8	25
lean alue	2.2	2.3	1.6	2.14	2.2	2.2	2.1	2.18
tand. evi.				0.38				0.25

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
1.4			1		1					
1.6										
1.8		1		1	2					
2.0		1			1	1				1
2.2				1	1	1	1	3	2	7
2.4	1		1		2		1		1	2
2.6							1	2		3
2.8								1		1
3.0		1			1					
Total	1	3	2	2	8	2	3	6	3	14
Mean Value	2.4	2.3	1.9	2.0	2.13	2.1	2.4	2.4	2.3	2.34
Stand. Devi.					0.46					0.22

with the body length were seen in the whales in the Japanese waters. This endorses the fact stated in the section (I), that is, the proportion of the head and caudal regions reach to the extremities at a definite body length. Such trend are also recognized in the Antarctic whales (Mackintosh and Wheeler, 1929), but the further discussion on this point will be stated in the next section. Only the comparison between the northern Pacific and the Japanese coastal waters is discussed in the present section.

Table II. (cont.)

A. Males

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
9.0		1		1				
9.5								
10.0								
10.5						1		1
11.0		1		1	1	2	1	4
11.5		1	1	2	1	4	1	6
12.0	1		1	2	1	1	4	6
12.5		1		1	1	3	2	6
13.0	1	1		2				
13.5					2			2
Total	2	5	2	9	6	11	8	25
Mean Value	12.5	11.4	11.8	11.72	12.3	11.6	11.9	11.90
Stand. Devi.				1.16				0.74

B. Females

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
10.0		1			1					
10.5									1	1
11.0			1	1	2		1	1	1	3
11.5				1	1		2	3	1	6
12.0			1	1	2	2		1		3
12.5		2			2					
13.0	1			1	2			1	1	2
Total	1	3	2	4	10	2	3	6	4	15
Mean Value	13.0	11.7	11.5	11.9	11.85	12.0	11.3	11.8	11.5	11.64
Stand. Devi.					0.93					0.67

17. Anterior end of lower border to tip of flipper

19. Greatest width of flipper

A. Males

Range of Values	1941				1952			
	17	18	19	To.	17	18	19	To.
2.3					1			1
2.4								
2.5					1	1		2
2.6						1		1
2.7					1	1		2
2.8		1		1	1	2	2	5
2.9	1	2		3	1	1	2	4
3.0	1		1	2		3	2	5
3.1		1		1			1	1
3.2		1	1	2		2		2
3.3					1		1	2
3.4		1		1				
Total	2	6	2	10	6	11	8	25
Mean Value	3.0	3.1	3.1	3.04	2.8	2.9	3.0	2.88
Stand. Devi.				0.17				0.24

B. Females

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
2.5									1	1
2.6				1	1					
2.7									1	1
2.8		1			1	2		1	1	4
2.9		1		1	2		1	3		4
3.0		1		1	2		1	2	1	4
3.1										
3.2	1				1		1			1
3.3			1	1	2					
Total	1	3	1	4	9	2	3	6	4	15
Mean Value	3.2	2.9	3.3	3.0	2.92	2.8	3.0	2.9	2.8	2.88
Stand. Devi.					0.19					0.16

As stated already the proportions of nos. 3 and 22 of the coastal finbacks increase with the body length, but this increasing trend ceases at the body length of 18 or 19 metres, as was the case in the northern

Table II. (cont.)

A. Males

20. Head length, condyle to tip

Range of Values	1941 (20)				1952 (22)			
	17	18	19	To.	17	18	19	To.
23.5					2	1		3
24.0						1	1	2
24.5		1		1		1	1	2
25.0	1	1		2	1	1	2	4
25.5		1		1		3	1	4
26.0					1	3	3	7
26.5		1		1	1	1		2
27.0					1			1
Total	1	4	0	5	6	11	8	25
Mean Value	25.0	25.4	—	25.30	25.3	25.3	25.3	25.26
Stand. Devi.				0.68				0.99

B. Females

22. Skull length, condyle to premaxilla

Range of Values	1941					1952				
	17	18	19	20	To.	17	18	19	20	To.
24.5	1				1				1	1
25.0				2	2	1			1	2
25.5								4	1	5
26.0			1	1	2		3			3
26.5						1				1
27.0								2	1	3
27.5										
28.0			1		1					
Total	1	0	2	3	6	2	3	6	4	15
Mean Value	24.5	—	27.0	25.3	25.91	25.8	26.0	26.0	25.5	25.84
Stand. Devi.					1.09					0.75

Pacific, showing the nearly same percentage against the body length. Also the decreasing trend of no. 10 is not seen at the body length of 18 or 19 metres in females, and its value approaches to that of the northern Pacific. Any remarkable differences between those in the both areas are not recognized on the whole number of measurements except no. 8 for males in which a higher value is seen in the coastal waters than the other.

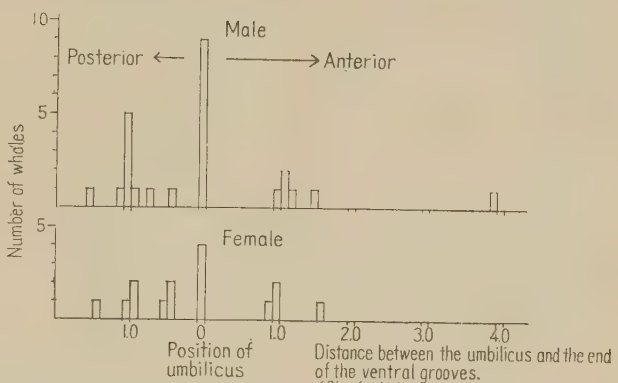

Fig. III. Position of the end of the ventral grooves against the umbilicus.

(III) Comparison between the northern Pacific and Antarctic fin whales: According to Mackintosh and Wheeler, the proportions of various parts representing the head and caudal regions increase or decrease with the growth of the body and reach to the extreme values at the body length of 22 or 23 metres and 19 or 20 metres in the South Georgian and in the South African fin whales, respectively. As the sexual maturities

Table III. a. Variation of the body proportions according to the growth of the fin whales taken from the adjacent water of Japan

% of body length	Male					
3.	15	16	17	18	19	Total
16.0	2					2
16.5						
17.0	3					3
17.5		1	1	1		3
18.0				1	1	2
18.5			1	3		4
19.0			1			1
19.5						
Total	5	1	3	5	1	15
Mean Value	16.6	17.5	18.3	18.2	18.0	

% of body length	Female							
3.	15	16	17	18	19	20	21	Total
16.0		1						1
16.5								
17.0	2							2
17.5	3		1	1				5
18.0				2				2
18.5					2		1	3
19.0			2		2			4
19.5			1		2	1		4
20.0			1					1
Total	5	1	5	3	6	1	1	22
Mean Value	17.3	16.0	19.0	17.8	19.0	19.5	18.5	

5.	15	16	17	18	19	Total
18.5	1					1
19.0	2		1			3
19.5						
20.0			1			1
20.5	2					2
21.0			1	2		3
21.5				1		1
22.0		1		1		2
22.5						
23.0						
23.5					1	1
Total	5	1	3	4	1	14
Mean Value	19.5	22.0	20.0	21.4	23.5	

5.	15	16	17	18	19	20	21	Total
17.0								
17.5								
18.0								
18.5	1		1					2
19.0	2			1				3
19.5		1						1
20.0	1			2				3
20.5			1		1	1		3
21.0			3		3			6
21.5	1							1
22.0					1			1
22.5								
23.0					1			1
23.5								
24.0							1	1
Total	5	1	5	3	6	1	1	22
Mean Value	19.8	19.5	20.4	19.7	21.4	20.5	24.0	

6.	15	16	17	18	19	Total
37	1	1	1			3
38						
39						
40			1	1	1	3
41	2					2
42	1			1		2
43			1	2		3
Total	4	1	3	4	1	13
Mean Value	40.3	37.0	40.0	42.0	40.0	

6.	15	16	17	18	19	20	21	Total
37	2			1				3
38	2	1						3
39			1	1	3			5
40			2		2	1		5
41			1	1	1			3
42							1	1
43	1		1					2
Total	5	1	5	3	6	1	1	22
Mean Value	38.6	38.0	40.6	39.0	39.7	40.0	42.0	

Table III. a. (cont.)

% of body length	Male					
7.	15	16	17	18	19	Total
2.5	1					1
3.0				1		1
3.5			1			1
4.0	2		1	2	1	6
4.5	2	1		1		4
Total	5	1	2	4	1	13
Mean Value	3.9	4.5	3.8	3.9	4.0	

% of body length	Female							
7.	15	16	17	18	19	20	21	Total
3.0				1				1
3.5			1				1	2
4.0	1		1		1	1		4
4.5	3	1	3	2	2			11
5.0					3			3
Total	4	1	5	3	6	1	1	21
Mean Value	4.4	4.5	4.2	4.0	4.7	4.0	3.5	

8.	15	16	17	18	19	Total
23.0	1			1		2
23.5	1			1		2
24.0						0
24.5	1		1		1	3
25.0			2	2		4
25.5	1					1
26.0	1			1		2
Total	5	0	3	5	1	14
Mean Value	24.5	—	24.8	24.5	24.5	

8.	15	16	17	18	19	20	21	Total
19.5					1			1
20.0								
20.5							1	1
21.0					1			1
21.5						1		1
22.0								
22.5	1		2	1				4
23.0	1		1	1	2			5
23.5								
24.0			1	1				2
24.5					1			1
25.0		1						1
25.5	1		1					2
26.0								
26.5	1							1
27.0								
Total	4	1	5	3	5	1	1	20
Mean Value	24.4	25.0	23.5	23.2	22.2	21.5	20.5	

10.	15	16	17	18	19	Total
27.0				1		1
27.5				1	1	2
28.0			1	1		2
28.5			1	2		3
29.0	1					1
29.5	2	1	1			4
30.0						
30.5	2					2
Total	5	1	3	5	1	15
Mean Value	29.8	29.5	28.7	27.9	27.5	

10.	15	16	17	18	19	20	21	Total
27.0					1			1
27.5			1		1		1	3
28.0			1	2				3
28.5			1	1	1	1		4
29.0	2				2			4
29.5	2		1		1			4
30.0	1							1
30.5								
31.0			1					1
Total	5	0	5	3	6	1	1	21
Mean Value	29.4	—	28.9	28.2	28.4	28.5	27.5	

Table III. a. (cont.)

% of body length	Male					
11.	15	16	17	18	19	Total
44				2		2
45				2	1	3
46	1		2	1		4
47						
48	1		1			2
49	1					1
50	2	1				3
Total	5	1	3	5	1	15
Mean Value	48.6	50.0	46.7	44.8	45.0	

% of body length	Female							
11.	15	16	17	18	19	20	21	Total
42				1				1
43								
44			1					1
45				1	2			3
46	2		1		2			5
47	2		2		1	1		6
48			1		1			2
49				1				1
50								
51	1							1
Total	5	0	5	3	6	1	0	20
Mean Value	47.4	—	46.4	45.3	46.2	47.0	—	

12.	15	16	17	18	19	Total
43				3	1	4
44				1		1
45	1		2			3
46						
47	2					2
48	1	1				2
49	1					1
Total	5	1	2	4	1	13
Mean Value	47.2	48.0	45.0	43.3	43.0	

12.	15	16	17	18	19	20	21	Total
43				1			1	2
44	1		1		2			4
45	2		2		2	1		7
46			2	1	1			4
47	1				1			2
48	1							1
Total	5	0	5	2	6	1	1	20
Mean Value	45.8	—	45.2	44.5	45.2	45.0	43.0	

13.	15	16	17	18	19	Total
4.5	1					1
5.0						
5.5				1		1
6.0	2		1	1		4
6.5				1		1
7.0	1		1	1	1	4
7.5	1		1	1		3
8.0						
8.5						
9.0		1				1
Total	5	1	3	5	1	15
Mean Value	6.2	9.0	6.8	6.5	7.0	

13.	15	16	17	18	19	20	21	Total
1.0					1			1
1.5					1		1	2
2.0			1	2				3
2.5	4		3	1	2	1		11
3.0	1		1		1			3
3.5					1			1
Total	5	0	5	3	6	1	1	21
Mean Value	2.6	—	2.5	2.2	2.3	2.5	1.5	

Table III. a. (cont.)

% of body length	Male					
14.	15	16	17	18	19	Total
1.8					1	1
2.0	1		1	1		3
2.2				1		1
2.4	1		1	1		3
2.6	1			1		2
2.8	1		1	1		3
3.0						
3.2						
3.4		1				1
Total	4	1	3	5	1	14
Mean Value	2.5	3.4	2.4	2.4	1.8	

% of body length	Female							
14.	15	16	17	18	19	20	21	Total
1.4					1			1
1.6								
1.8	2		1		3		1	7
2.0				1				1
2.2			1	1		1		3
2.4	1		1	1				3
2.6	2		1					3
2.8					1			1
3.0					1			1
Total	5	0	4	3	6	1	1	20
Mean Value	2.2	—	2.3	2.2	2.1	2.2	1.8	

15.	15	16	17	18	19	Total
3.5			2	1		3
4.0			1	3		4
4.5	1					1
5.0	1				1	2
5.5	1			1		2
6.0	2	1				3
Total	5	1	3	5	1	15
Mean Value	4.2	5.5	3.7	4.2	5.0	

15.	15	16	17	18	19	20	21	Total
3.0					1		1	2
3.5					1			1
4.0	2		1	1				4
4.5	1		1	2	2			6
5.0			1		1	1		3
5.5	1		2					3
6.0	1							1
Total	5	0	5	3	5	1	1	20
Mean Value	4.8	—	4.9	4.3	4.1	5.0	3.0	

17.	15	16	17	18	19	Total
9.0			1			1
9.5						
10.0					1	1
10.5		1				1
11.0	2		1			3
11.5				2		2
12.0	1					1
12.5	1			1		2
13.0			1			1
13.5	1			1		2
Total	5	1	3	4	1	14
Mean Value	12.0	10.5	11.0	12.3	10.0	

17.	15	16	17	18	19	20	21	Total
10.0			1					1
10.5	2							2
11.0	1		2		2	1	1	7
11.5			1		1			2
12.0	1		1	1	3			6
12.5	1			2				3
Total	5	0	5	3	6	1	1	21
Mean Value	11.3	—	11.1	12.3	11.6	11.0	11.0	

Table III. a. (cont.)

% of body length	Male					
19.	15	16	17	18	19	Total
2.1			1			1
2.2						
2.3						
2.4						
2.5	1	1				2
2.6	2					2
2.7				1		1
2.8	1		1		1	3
2.9						
3.0	1					1
3.1				1		1
3.2				2		2
3.3			1			1
Total	5	1	3	4	1	14
Mean Value	2.7	2.5	2.7	3.1	2.8	

% of body length	Female							
19.	15	16	17	18	19	20	21	Total
2.5							1	1
2.6								
2.7	1							1
2.8	4		1		2			7
2.9			2	1		1		4
3.0			1		2			3
3.1			1	1	1			3
3.2				1	1			2
Total	5	0	5	3	6	1	1	21
Mean Value	2.8	—	2.9	3.1	3.0	2.9	2.5	

21.	15	16	17	18	19	Total
10.0	1					1
10.5						
11.0	2	1	2	2		7
11.5	2			1		3
12.0				1	1	2
12.5			1			1
Total	5	1	3	4	1	14
Mean Value	11.0	11.0	11.5	11.4	12.0	

21.	15	16	17	18	19	20	21	Total
10.0	2	1			1			4
10.5	1			1		1	1	4
11.0	1				3			4
11.5			4	1				5
12.0			1					1
12.5				1				1
13.0								
13.5					1			1
Total	4	1	5	3	5	1	1	20
Mean Value	10.4	10.0	11.6	11.5	11.3	10.5	10.5	

22.	15	16	17	18	19	Total
22.0	1					1
22.5		1				1
23.0	1		1			2
23.5						
24.0	1					1
24.5	2		2			4
25.0						
25.5				1		1
26.0				2	1	3
26.5				1		1
Total	5	1	3	4	1	14
Mean Value	23.6	22.5	24.0	26.0	26.0	

22.	15	16	17	18	19	20	21	Total
22.5		1						1
23.0	1							1
23.5	1		1					2
24.0	1							1
24.5	1			2				3
25.0					1			1
25.5			2	1	4	1		8
26.0			2					2
26.5								
27.0							1	1
Total	4	1	5	3	5	1	1	20
Mean Value	23.8	22.5	25.3	24.8	25.4	25.5	27.0	

Table III. b. Variation of the body proportions according to the growth of the northern Pacific fin whales

% of body length	Male			
3.	17	18	19	Total
16.5		1		1
17.0		2		2
17.5	2	1	2	5
18.0	1	3	2	6
18.5	3	3	1	7
19.0		4	3	7
19.5		1	2	3
20.0	1	1		2
20.5	1			1
21.0		1		1
Total	8	17	10	35

% of body length	Female				
3.	17	18	19	20	Total
17.5	1		2	1	4
18.0	1				1
18.5	1	1	2	3	7
19.0		2	2	1	5
19.5		2	2	1	5
20.0				1	1
20.5				1	1
21.0					
21.5					
Total	3	5	8	8	24

5.	17	18	19	Total
19.0	1			1
19.5	1	5	2	8
20.0	1	2	1	4
20.5	2	1	2	5
21.0		2	2	4
21.5	1	5	2	8
22.0		2	1	3
22.5	2			2
Total	8	17	10	35

5.	17	18	19	20	Total
19.5	1				1
20.0					
20.5	1	2	2	2	7
21.0	1	1	2	3	7
21.5		2	2	2	6
22.0		1	1	1	3
22.5					
23.0			1		1
Total	3	6	8	8	25

6.	17	18	19	Total
36				
37				
38				
39		1		1
40	2	1	1	4
41		4	1	5
42	2	3	2	7
43	1	3	2	6
44	2	2	1	5
45			2	2
46		1		1
47				
Total	7	15	9	31

6.	17	18	19	20	Total
39				1	1
40		2	1		3
41		2	2	2	6
42	2	1	3	2	8
43	1			2	3
44			1		1
Total	3	5	7	7	22

Table III. b. (cont.)

% of body length	Male			
10.	17	18	19	Total
25.0	1			1
25.5				
26.0			1	1
26.5	2	1	3	6
27.0	2	2	2	6
27.5		6	1	7
28.0	1	4	1	6
28.5	1	2		3
29.0			1	1
29.5	1	1	1	3
30.0		1		1
Total	8	17	10	35
11.	17	18	19	Total
42			1	1
43		2	2	4
44	3	1	3	7
45	2	5	1	8
46		3	2	5
47	1	1	1	3
48	1	1		2
Total	7	13	10	30
12.	17	18	19	Total
41	1			1
42	1	3	1	5
43		1	3	4
44	2	2	2	6
45		7	1	8
46	3		1	4
47	1	1	2	4
48		2		2
Total	8	16	10	34
15.	17	18	19	Total
3.0			1	1
3.5	1			1
4.0	1	1	1	3
4.5		5	2	7
5.0	2	2	1	5
5.5	2	1		3
6.0		1	2	3
6.5		1	1	2
Total	6	11	8	25

% of body length	Female				
10.	17	18	19	20	Total
25.5			2		2
26.0			1		1
26.5		1	2		3
27.0				1	1
27.5		1	1	5	7
28.0	1	1	1	1	4
28.5					
29.0	1	2	1		4
29.5					
30.0		1			1
30.5	1			1	2
Total	3	6	8	8	25
11.	17	18	19	20	Total
41			2		2
42			1		1
43			1		1
44	1	1	1	2	5
45	1	2	1	2	6
46			1	1	2
47	1	2			3
Total	3	5	7	5	20
12.	17	18	19	20	Total
41			2	2	4
42			2	1	3
43	1		1	1	3
44	1	2	2	1	6
45	1		1	2	4
46		3		1	4
47					
48		1			1
Total	3	6	8	8	25
15.	17	18	19	20	Total
3.0				1	1
3.5			2	1	3
4.0					
4.5		1			1
5.0	1	1	2		4
5.5	1		1	1	3
6.0				1	1
6.5		1	1		2
Total	2	3	6	4	15

Table III. b. (cont.)

% of body length	Male			
21.	17	18	19	Total
10.5	1		3	4
11.0	2	2	1	5
11.5	2	3	1	6
12.0	1	6	3	10
Total	6	11	8	25

% of body length	Female				
21.	17	18	19	20	Total
10.5				1	1
11.0	1	1		1	3
11.5		1	2	2	5
12.0		1	4		5
12.5	1				1
Total	2	3	6	4	15

22.	17	18	19	Total
23.5	2	1		3
24.0		1	1	2
24.5		1	1	2
25.0	1	1	2	4
25.5		3	1	4
26.0	1	3	3	7
26.5	1	1		2
27.0	1			1
27.5				
Total	6	11	8	25

22.	17	18	19	20	Total
24.5				1	1
25.0	1				1
25.5			4	2	6
26.0		3			3
26.7	1				1
27.0			2	1	3
Total	2	3	6	4	15

are attained at the body length of 19.5 metres in males and 20 metres in females, it may be concluded from these facts that the extreme values of proportions are reached after the sexual maturities are attained. Such trends are also seen in the northern Pacific. H. Sakiura, K. Ozaki and K. Fujino (1953) stated that the sexual maturities are attained at the body length of 57 or 59 ft. (17.40 or 18.10 metres) in male and 61 ft. (18.60 metres) in female in most of the northern Pacific fin whales. These body lengths are nearly the same or slightly smaller than the lengths at which the proportion of head region reaches to its maximum, namely 18 or 19 metres. This fact may be explained from the assumption that the advancing velocities of the ossification of the cervical and caudal vertebrae are different from each other after the sexual maturities are attained.

Comparing the northern Pacific and the Antarctic fin whales, keeping in mind the above consideration, it is noted that the differences in the head and caudal regions are only recognized after the former reached its body length of 18 or 19 metres. In other items, namely nos. 8, 14, 15, 17, 19 and 21, some differences are seemed to exist between both areas as shown in Figure IV. It may be seen from this figure that the northern Pacific fin whales have (1) smaller and more posteriorly situated

Table IV. Correlation coefficient r between the body proportions y and the body length x

Measurement	northern Pacific		Adjacent waters of Japan	
	Male	Female	Male	Female
No. 3	0.0	0.2	0.8	0.6
〃 5	0.0	0.3	0.9	0.6
〃 6	0.1	0.0	0.3	0.3
〃 7	−0.2	−0.2	0.0	−0.1
〃 8	−0.2	−0.2	−0.01	−0.6
〃 10	0.0	−0.2	−0.8	−0.5
〃 11	−0.2	−0.3	−0.8	−0.3
〃 12	0.0	−0.3	−0.9	−0.4
〃 13	−0.2	0.0	0.1	−0.3
〃 14	−0.2	−0.1	−0.3	−0.2
〃 15	0.1	−0.3	−0.5	−0.4
〃 17	−0.2	−0.1	−0.1	0.1
〃 19	0.3	−0.1	0.1	0.4
〃 21	−0.1	−0.3	0.4	0.1
〃 22	0.0	−0.1	0.7	0.7

dorsal fin (nos. 8, 14 and 15). (2) the bigger flippers (nos. 17 and 19) and (3) the slightly wider skull (no. 21) than the Antarctic. However, no differences are found in no. 20 (or 22) which represents the head (or skull) length. So it can be concluded that the Antarctic finback has the lanker skull (Fig. V). This difference in the width of skull seems to be characteristic and can be regarded as racial, so it will be stated later in detail.

(IV) Correlation between the number of corpora lutea and growth of various parts of body: As pointed out in the sections II and III, the remarkable variations of the rate of growth on the head and caudal regions are recognized after the whale attained its sexual maturity. In relation to this trend Wheeler (1930) stated on the Antarctic finbacks "(1) Ankylosis of the epiphyses starts from both ends of the vertebral column, but anteriorly it does not proceed much beyond the cervical series, Ankylosis is completed among the anterior thoracic vertebrae and (2) complete ankylosis—that is, physical maturity—bears little relation to length, but is found when more than fifteen corpora lutea are present in the ovaries."

The relation between the number of corpora lutea and growth of various parts of the body is shown in Fig. VI, separately those in the northern Pacific in 1952 and those in the Antarctic in 1948–51, in which some differences according to the areas are shown. It may be said from this figure that the Antarctic females show the larger value than the

northern Pacific in all items. It should be left in future investigation that how many corpora lutea should be accumulated when the growth of the various parts of the body ceases, because of the scantiness of the data at present. Correlation coefficients of "skull length" to the number of corpora lutea are 0.6 in 1948–51 Antarctic and 0.7 in 1952 northern Pacific females. This shows that the length of skull has a positive correlation with the number of corpora lutea, and has the smaller variances than the other items. In other words, the actual length of skull is closely related with the age of whale.

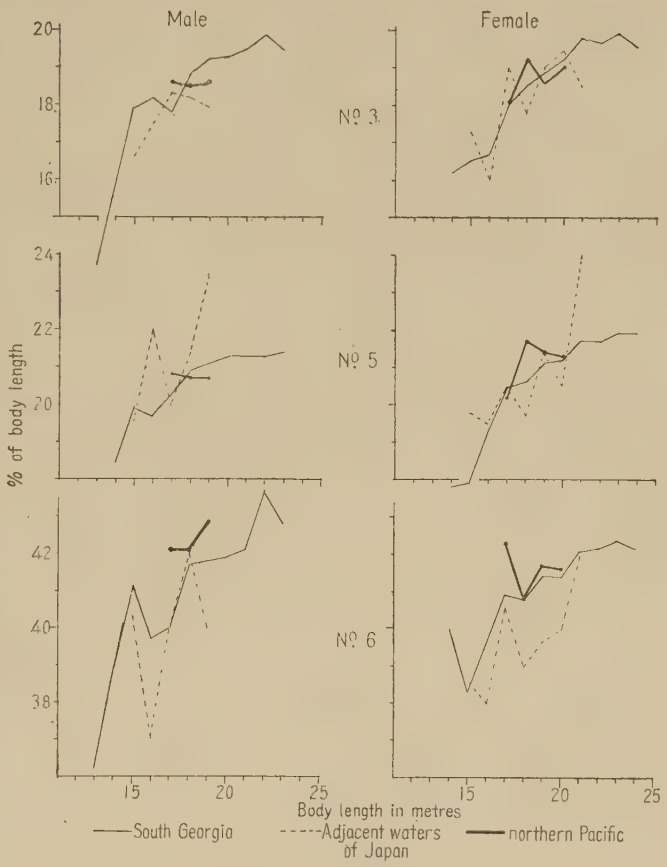

Fig. IV. Comparison of the body proportions between the northern Pacific, Adjacent Waters of Japan and Antarctic Fin whales.

(V) Correlation between the number of corpora lutea and the proportions of skull: As stated in sections III and IV, shape of the skull seems to be very useful as a indicator for the study of the problems of the races. So I should like to discuss here still more on this problem using the data obtained in 1948–51 Antarctic and 1952 northern Pacific, though the data are not sufficient yet.

The measurements of the skull were made on the following items:

no. 21 greatest width of the skull
no. 22 skull length, condyle to tip of premaxilla
no. 26 distance between the tips of the both pterygoids

no. 27 length of the rostrum
no. 28 width of the rostrum at base

Table V. Measurements of skull proportions of the mature female fin whales

Measurement number	Parts of skull, examined	northern Pacific in 1952	Antarctic in 1949~1951
21	Greatest width of skull	11	16
22	Skull length, condyle to tip of premaxilla	11	16
26	Distance between the tips of both pterygoid	11	7
27	Length of rostrum	11	6
28	Width of rostrum at the base.	11	6

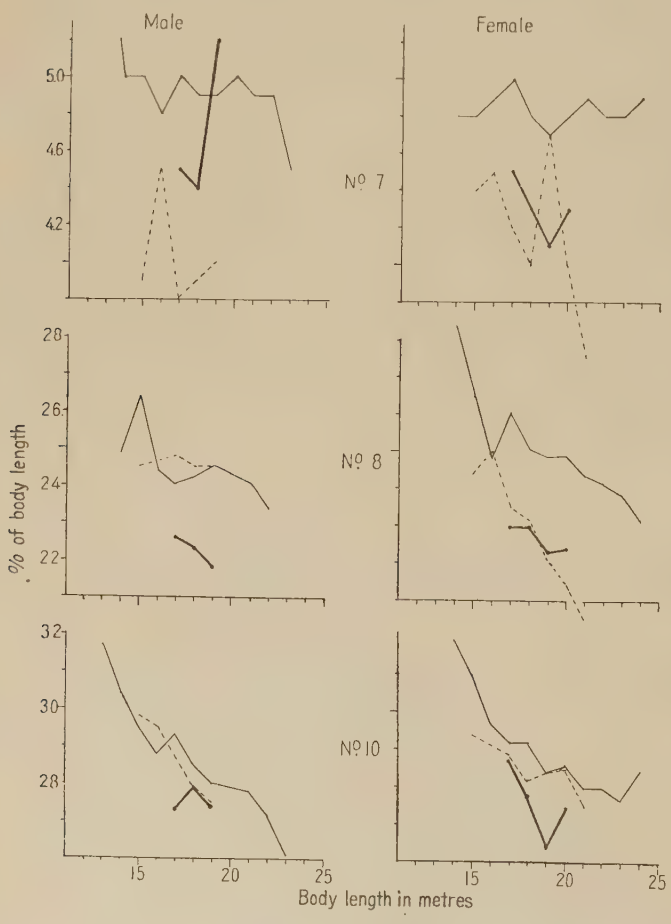

Fig. IV. (cont.)

The correlations between the number of corpora lutea and proportions of various parts against the skull length is shown in Figure VII. According to this figure, in 27/22 and 28/22 on differences are recognized, but in 21/22 and 26/22 the northern Pacific shows the larger value than the Antarctic, that is to say, the Antarctic females have the larger skull than the northern Pacific females, even possessing the equal number of corpora lutea.

As regards the variation according to the accumulation of corpora lutea, 21/22 of the Antarctic

female reaches to its maximum at the numbers between 10 and 15 of corpora lutea and then turns to decreasing. From this fact, the following may be drawn regarding the Antarctic female fin whale:

(1) Growth of the skull in length will be continued even after the number of corpora lutea reached to 10 to 15.

(2) Growth of the skull in width becomes very slow or cease when the number of corpora lutea reached to 10 to 15.

From the observation of ossification of vertebrae, Wheeler (1930) concluded that the physical maturity of the Antarctic female fin whale is attained at the number of corpora lutea of 15. Considering this fact together with the fact above stated, it may be thought that the complete cessation in growth of the skull is attained after the ossification of the vertebrae is completed. As regards the northern Pacific finbacks the discussions on this point should be left to the future investigation owing to the scantiness of materials.

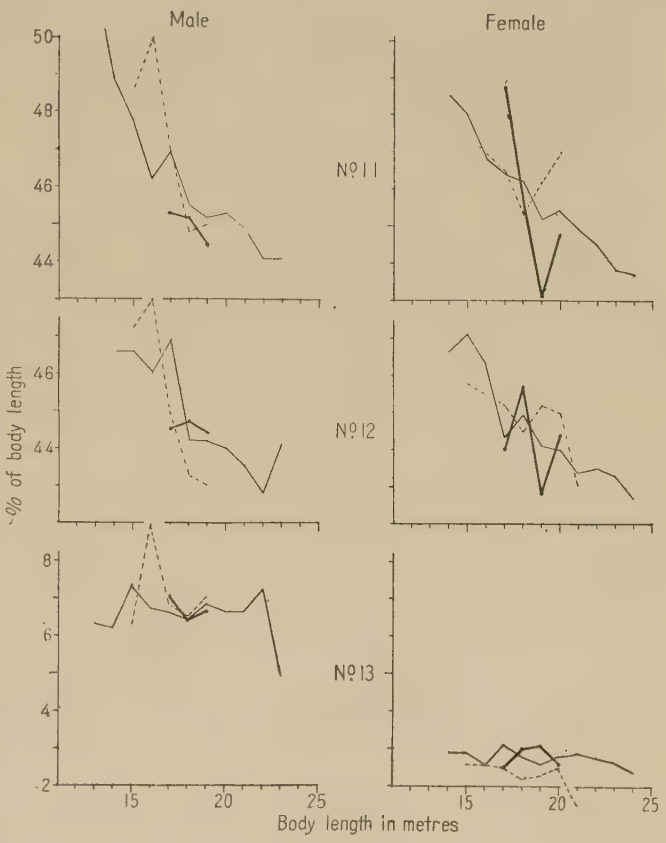

Fig. IV. (cont.)

Number of ventral grooves

Two times of the number of ventral grooves on one side between the axilla of the flipper and mid-ventral line are deemed as the "number of ventral grooves". Comparison between the northern Pacific and the Antarctic (data given by Mackintosh and Wheeler, 1929) are shown in

Table VI. Frequencies of the number of ventral grooves.*

No. of Ventral Grooves	Males			Females		
	n. Pacific	S. Georgia	S. Africa	n. Pacific	S. Georgia	S. Africa
50~ 60	1			1		
60~ 70	13	1		10		
70~ 80	9	10	2	2	5	1
80~ 90	2	7	3	2	12	10
90~100		4	3		8	2
100~110		3			6	
110~120					3	
Total	25	25	8	15	34	13
Average	65	84	85	63	91	85
Range	58~84	68~106	76~94	50~86	72~114	78~98
Standard Deviation	7.0	—	—	7.9	—	—

* S. Georgia's and S. Africa's were cited from the Discovery Reports Vol. I, p. 358

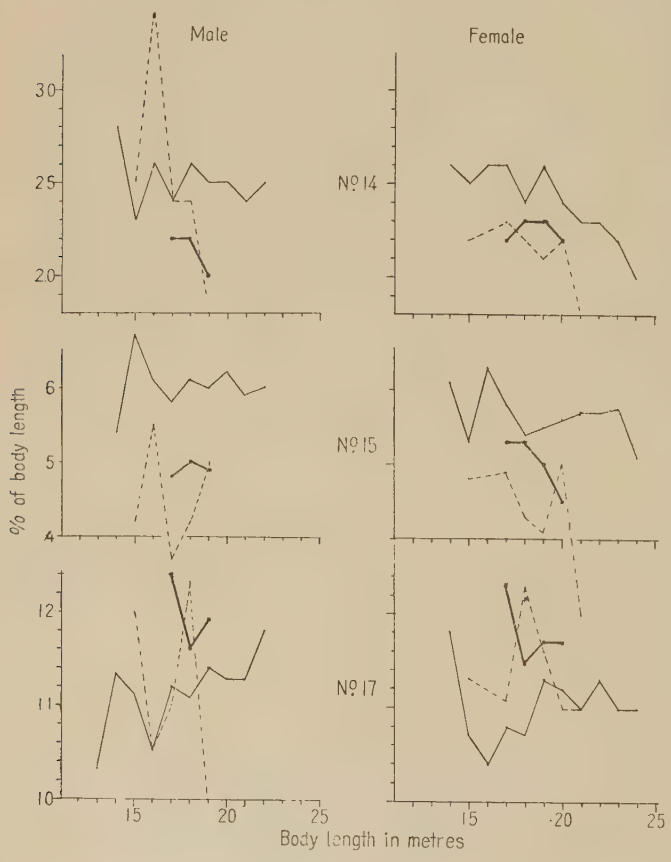

Fig. IV. (cont.)

Table VI. According to this table, the northern Pacific has fewer ventral grooves than the latter. However, the different way of counting from that followed by Discovery Investigations was used by us, so the definite conclusion may not be reached here.

Summary

(I) Measurements of body proportions were carried out by the methods which was used by Mackintosh and Wheeler. Analysing the data obtained according to the different areas

the following conclusions have been reached, though the final conclusions will be reached in future when more sufficient data are available.

(1) No remarkable differences are recognized between the Japanese coastal fin whales captured during the years from 1949 to 1951 and those in the northern Pacific in the years of 1941 and 1952.

(2) Between the northern Pacific and the Antarctic fin whales,

(a) Any differences on "skull length" and "distance from tip of snout to centre of eye", which represent the head region, were not recognized among whales of which body length is less than 18 or 19 metres. However, after the attaining of sexual maturity in the northern Pacific whales the value varies each other abruptly according to the rise of body length. That is to

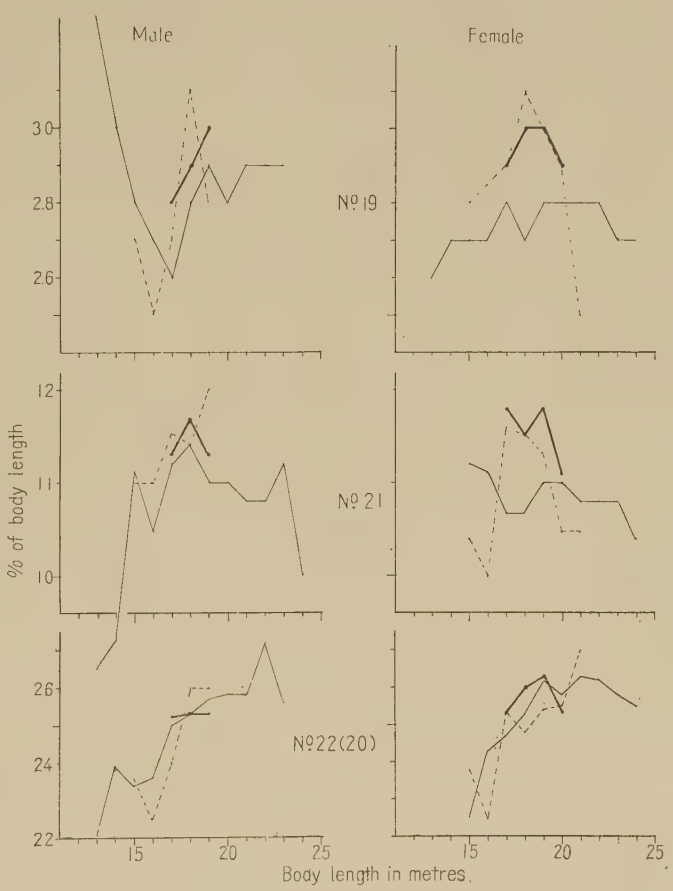

Fig. IV. (cont.)

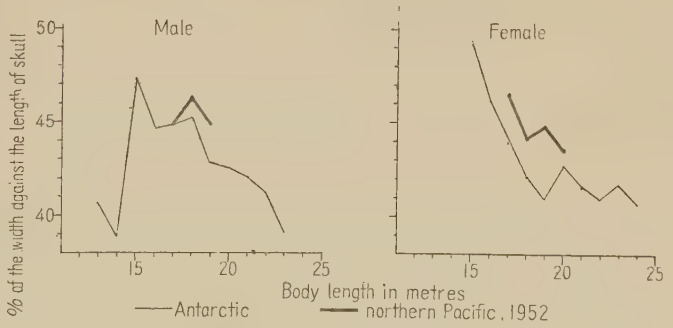

Fig. V. Comparison of the proportion of the greatest width against the length of skull, between the northern Pacific and the Antarctic Fin whales.

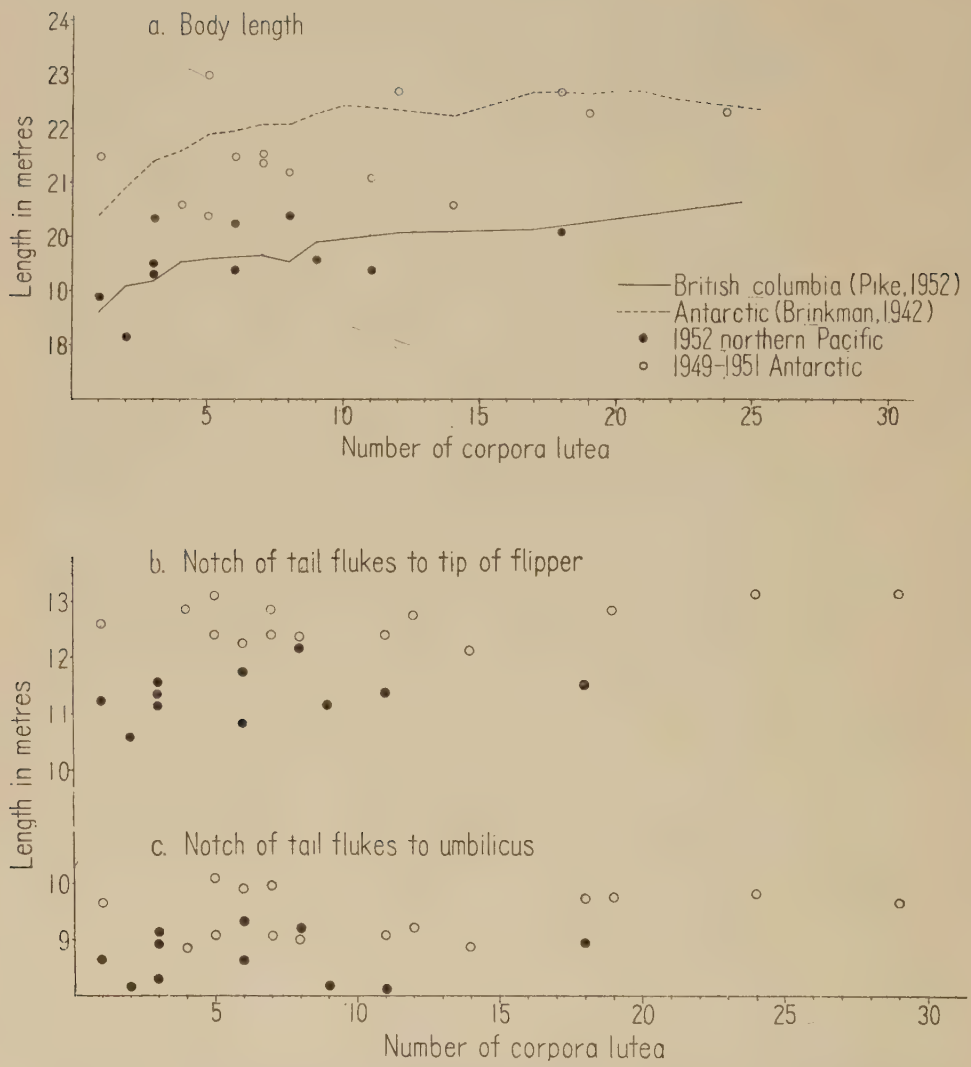
a. Body length
Length in metres
British columbia (Pike, 1952)
Antarctic (Brinkman, 1942)
1952 northern Pacific
1949-1951 Antarctic
Number of corpora lutea
b. Notch of tail flukes to tip of flipper
c. Notch of tail flukes to umbilicus
Length in metres
Number of corpora lutea

Fig. VI. Correlation between the number of corpora lutea and the dimensions of the various parts of body.

say, the Antarctic finback have a larger head and smaller caudal parts than the other after attaining of the sexual maturity.

(b) As regards the items of nos, 8, 14, 15, 17, 19 and 21, some differences are recognized, that is, the northern Pacific finback possesses more posteriorly situated and smaller dorsal fin, and the bigger flippers. (II) As regards the correlation between number of corpora lutea and the actual length of body dimensions, following results were obtained.

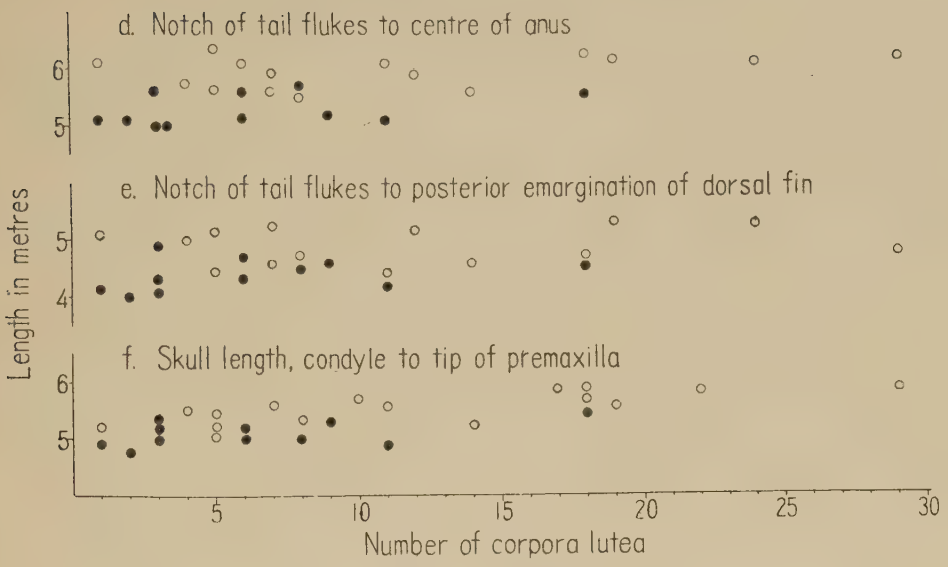
d. Notch of tail flukes to centre of anus
e. Notch of tail flukes to posterior emargination of dorsal fin
f. Skull length, condyle to tip of premaxilla
Length in metres
Number of corpora lutea

Fig. VI. (cont.)

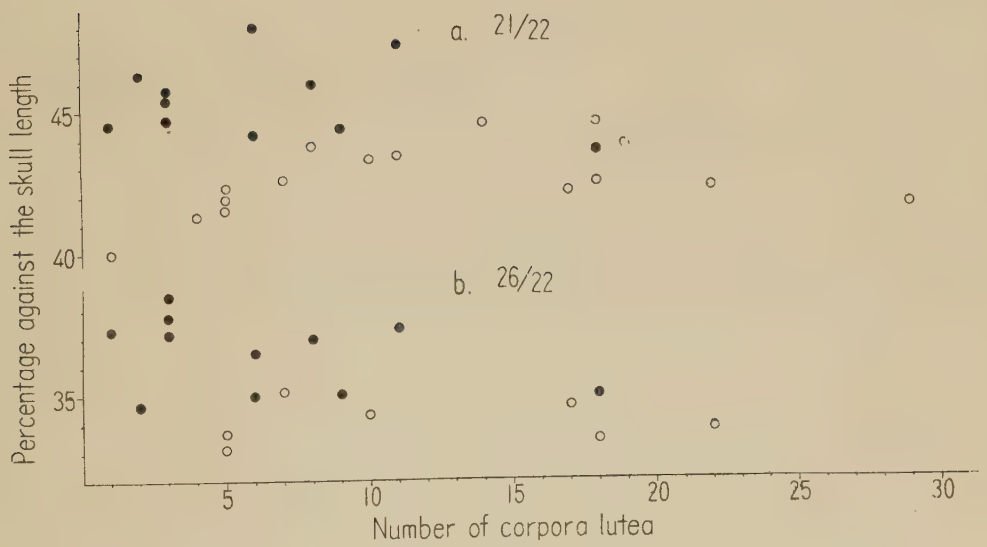

Fig. VII. Correlation between the number of corpora lutea and the growth of the body parts lengths.

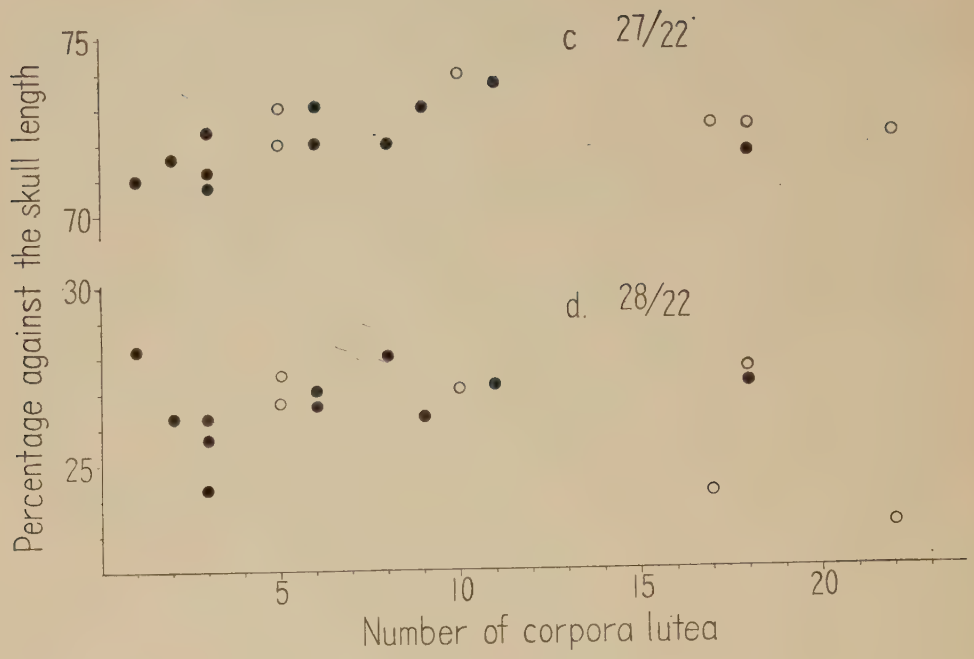

Fig. VII. (cont.)

(1) It is clear that the Antarctic finback is larger in the items of total length, distance from the notch of tail flukes to tip of flipper, distance from the same point to umbilicus, distance from the same point to anus and head length.

(2) In proportions of the rostrum length and its width at base against the skull length, no differences are recognized, but the northern Pacific whale has a wider skull when compared the greatest width of the skull each other, namely more rounded face.

(III) Number of ventral grooves

Two times of the number of ventral grooves on one side between the axilla of the flipper and mid-ventral line are deemed as the "number of ventral grooves", and these are compared with the data in the Antarctic described in the Discovery Reports. In seems that the northern Pacific whales have the fewer number of ventral grooves than the South Georgian and South African fin whales. However, a different way of counting was followed in the northern Pacific, so the definite conclusion may not be reached at present.

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Appendix A

Measurements of Body Proportions of the Fin whales examined in the northern Pacific, Adjacent Waters of Japan and Antarctic.

Upper figures: actual value in metres
Lower figures: percentages against total length

Measurement No. 1. Total length, tip of snout to notch of flukes.
(upper: in meters / lower: in feet)

〃 〃 3. Tip of snout to blow-hole.
〃 〃 5. Tip of snout to centre of eye.
〃 〃 6. Tip of snout to tip of flipper.
〃 〃 7. Centre of eye to centre of ear.
〃 〃 8. Notch of flukes to posterior emargination of dorsal fin.
〃 〃 10. Notch of flukes to centre of anus.
〃 〃 11. Notch of flukes to umbilicus.
〃 〃 12. Notch of flukes to end of system of ventral grooves.
〃 〃 13. Centre of anus to centre of reproductive aperture.
〃 〃 14. Vertical height of dorsal fin.
〃 〃 15. Length of base of dorsal fin.
〃 〃 17. Anterior end of lower border to tip of flipper.
〃 〃 19. Greatest width of flipper.
〃 〃 20. Length of severed head from condyle to tip.
〃 〃 21. Greatest width of skull.
〃 〃 22. Skull length, condyle to tip of premaxilla.

I. Nothern Pacific, Males, 1941 (Cited from the Biological Investigation of the northern Pacific whales by Matsura, Y. and Maeda, K., 1942)

Whale No.	Date, killed	1	3	5	6	7	8	10	11	12	13	14	17	19	20
19	Aug. 1	17.40													
		57	18.5	19.7	—	4.7	23.4	28.4	48.8	46.2	7.9	2.6	12.4	3.0	25.0
10	June 28	17.90													
		59	17.6	20.3	42.4	4.7	23.6	29.8	—	46.3	8.6	1.9	13.2	2.9	—
17	July 19	18.10													
		60	18.2	19.9	42.1	4.8	24.4	28.1	—	42.6	7.0	—	—	2.8	24.6
3	June 18	18.30													
		60	17.1	20.7	42.6	4.8	—	28.5	—	45.8	7.3	1.8	11.1	3.2	—
4	〃 〃	18.30													
		60	18.8	20.3	46.0	4.5	22.5	29.7	—	45.0	5.9	—	9.2	3.1	25.5
8	〃 23	18.60													
		61	18.4	20.0	—	4.6	24.5	28.1	—	—	7.0	2.4	11.7	2.9	25.3
20	Aug. 14	18.80													
		62	21.2	21.7	43.6	5.0	21.9	27.5	46.3	42.6	6.4	2.3	12.9	2.9	26.5
18	July 25	18.90													
		62	20.2	21.7	43.8	6.6	22.3	27.3	45.3	42.2	6.7	2.6	13.0	3.4	26.5
9	June 25	19.10													
		63	17.6	19.7	—	4.9	—	29.5	47.1	47.1	7.1	—	11.7	3.0	—
12	July 8	19.20													
		63	19.2	21.5	42.7	4.3	21.8	26.8	45.7	44.2	8.0	1.7	12.0	3.2	—

I. Northern Pacific, Females, 1941 (Cited from the Biological Investigation of the northern Pacific whales by Matsura, Y. and Maeda, K., 1942)

Whale No.	Date, killed	1	3	5	6	7	8	10	11	12	13	14	17	19	20
14	July 15	17.00													
		56	18.4	20.5	42.1	4.6	—	30.9	47.9	45.9	2.9	2.5	13.0	3.2	24.8
13	〃 10	18.20													
		60	19.3	20.7	41.3	4.2	23.8	30.2	47.2	46.5	3.2	2.1	10.3	2.8	—
1	June 9	18.50													
		61	—	21.0	—	4.6	25.1	29.0	47.2	48.5	3.3	3.0	12.5	3.0	—
7	〃 21	18.90													
		62	18.9	20.7	42.5	4.5	23.3	29.2	—	46.7	3.7	1.8	12.7	2.9	—
11	July 6	19.40													
		64	19.7	20.9	40.6	4.5	25.0	29.2	45.2	44.4	3.1	1.4	12.0	3.3	26.4
6	June 20	19.50													
		64	19.9	22.2	—	4.8	21.9	27.5	—	43.1	3.6	2.5	11.0	—	28.0
15	July 15	20.00													
		66	20.5	21.7	43.2	5.2	21.8	27.7	—	41.8	2.4	—	13.0	3.3	—
16	〃 18	20.30													
		67	18.5	20.9	—	4.5	—	28.1	45.5	43.1	2.4	1.8	11.6	3.0	25.1
2	June 17	20.60													
		68	19.2	20.6	41.7	4.9	21.6	30.6	—	41.6	3.4	—	12.1	2.6	26.4
5	〃 18	20.90													
		69	19.5	21.4	41.7	4.2	22.5	27.0	—	42.0	2.7	2.3	11.3	2.9	25.2

II. Northern Pacific, Males, 1952

Whale No.	Date, killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22	29
135	Aug. 20	17.28	3.55	3.90	7.65	0.80	3.80	4.70	7.90	7.70	1.10	0.50	0.90	2.40	0.40	—	2.05	4.60	62
		57	**20.5**	**22.6**	**44.3**	**4.6**	**22.0**	**27.2**	**45.7**	**44.6**	**6.4**	**2.9**	**5.2**	**13.9**	**2.3**	—	**11.9**	**26.6**	—
263	Sept. 10	17.38	3.25	3.65	7.40	0.75	4.00	4.70	7.30	7.20	1.25	0.35	0.90	2.10	0.51	—	1.96	4.40	64
		57	**18.7**	**21.0**	**42.6**	**4.3**	**23.0**	**27.0**	**42.0**	**41.0**	**7.2**	**2.0**	**5.2**	**12.1**	**2.9**	—	**11.2**	**25.3**	—
281	Sept. 14	17.60	3.25	3.85	7.80	0.80	3.60	4.70	7.80	7.80	1.10	0.40	1.00	2.25	0.48	—	2.15	4.60	78
		58	**18.5**	**21.9**	**44.3**	**4.5**	**20.5**	**26.7**	**44.3**	**44.3**	**6.2**	**2.3**	**5.7**	**12.8**	**2.7**	—	**12.2**	**26.1**	—
167	Aug. 25	17.70	3.60	4.00	7.70	0.80	4.00	4.80	7.80	7.60	1.30	0.30	0.70	2.40	0.58	—	2.10	4.80	68
		58	**20.3**	**22.6**	**43.5**	**4.5**	**22.6**	**27.1**	**44.1**	**42.9**	**7.3**	**1.7**	**4.0**	**13.6**	**3.3**	—	**11.9**	**27.1**	—
169	Aug. 25	17.70	3.10	3.40	7.15	0.85	4.30	5.10	8.40	8.40	1.20	0.40	1.00	2.00	0.49	—	2.00	4.20	68
		58	**17.5**	**19.2**	**40.4**	**4.8**	**24.3**	**28.8**	**47.5**	**47.5**	**6.8**	**2.3**	**5.6**	**11.3**	**2.8**	—	**11.3**	**23.7**	—
38	July 28	17.76	3.25	3.65	7.20	0.80	4.00	4.50	8.00	8.20	1.40	0.40	0.70	2.20	0.45	—	1.88	4.25	64
		58	**18.3**	**20.6**	**40.5**	**4.5**	**22.5**	**25.3**	**45.0**	**46.2**	**7.9**	**2.3**	**3.9**	**12.4**	**2.5**	—	**10.6**	**23.9**	—
261	Sept. 10	18.05	3.35	3.85	7.30	0.85	3.90	4.90	7.80	8.50	1.20	0.40	1.20	2.25	0.57	—	2.20	4.75	64
		60	**18.6**	**21.3**	**40.4**	**4.7**	**21.6**	**27.1**	**43.2**	**47.1**	**6.6**	**2.2**	**6.6**	**12.5**	**3.2**	—	**12.2**	**26.3**	—
14	July 22	18.20	3.50	4.00	—	0.65	4.00	4.90	7.90	8.10	1.20	0.36	0.90	2.30	0.45	—	2.25	4.90	60
		60	**19.2**	**22.0**	—	**3.6**	**22.0**	**26.9**	**43.4**	**44.5**	**6.6**	**2.0**	**4.9**	**12.6**	**2.5**	—	**12.4**	**26.9**	—
170	Aug. 25	18.30	3.30	3.60	7.50	0.80	4.10	5.10	8.90	8.90	1.10	0.40	0.90	2.07	0.55	—	2.20	4.70	74
		60	**18.0**	**19.7**	**41.0**	**4.4**	**22.4**	**27.9**	**48.6**	**48.6**	**6.0**	**2.2**	**4.9**	**11.3**	**3.0**	—	**12.0**	**25.7**	—
222	Sept. 3	18.30	3.20	3.65	7·20	0.80	4.30	5.20	8.60	8.80	1.20	0.40	0.80	2.00	0.53	—	2.20	4.55	72
		60	**17.5**	**19.9**	**39.3**	**4.4**	**23.5**	**28.4**	**47.0**	**48.1**	**6.6**	**2.2**	**4.3**	**10.9**	**2.9**	—	**12.0**	**24.9**	—
259	Sept. 10	18.54	3.60	4.00	7.80	0.80	4.00	5.30	8.50	8.40	1.40	0.40	1.10	2.30	0.60	—	2.15	4.90	70
		61	**19.4**	**21.6**	**42.1**	**4.3**	**21.6**	**28.6**	**45.8**	**45.3**	**7.6**	**2.2**	**5.9**	**12.4**	**3.2**	—	**11.6**	**26.4**	—
276	Sept. 14	18.56	3.65	4.00	8.30	0.85	4.20	5.10	8.50	8.50	1.30	0.50	0.90	2.20	0.55	—	2.18	4.90	84
		61	**19.7**	**21.6**	**44.7**	**4.6**	**22.6**	**27.5**	**45.8**	**45.8**	**7.0**	**2.7**	**4.8**	**11.9**	**3.0**	—	**11.7**	**26.4**	—
113	Aug. 13	18.61	3.15	3.70	7.65	0.85	4.00	5.20	8.50	8.30	1.20	0.45	0.90	2.10	0.50	—	2.10	4.50	76
		61	**16.9**	**19.9**	**41.1**	**4.6**	**21.5**	**27.9**	**45.7**	**44.6**	**6.4**	**2.4**	**4.8**	**11.3**	**2.7**	—	**11.3**	**24.2**	—
223	Sept. 4	18.63	3.25	3.70	7.70	0.80	4.30	5.20	8.30	8.10	1.20	0.45	0.90	2.20	0.52	—	2.10	4.45	70
		61	**17.4**	**19.9**	**41.3**	**4.3**	**23.1**	**27.9**	**44.6**	**43.5**	**6.4**	**2.4**	**4.8**	**11.8**	**2.8**	—	**11.3**	**23.9**	—
288	Sept. 16	18.70	3.50	4.00	7.80	0.80	4.00	5.30	8.50	8.50	1.30	0.40	1.00	2.20	0.56	—	2.15	4.70	84
		61	**18.7**	**21.4**	**41.7**	**4.3**	**21.4**	**28.3**	**45.5**	**45.5**	**7.0**	**2.1**	**5.3**	**11.8**	**3.0**	—	**11.5**	**25.1**	—

II. Northern Pacific, Males, 1952 (cont.)

Whale No.	Date, killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22	29
162	Aug. 24	18.90	3.60	4.10	8.35	0.80	4.20	5.70	8.80	8.50	1.20	0.46	1.20	2.40	0.52	—	2.30	4.90	70
		62	**19.0**	**21.7**	**44.2**	**4.2**	**22.2**	**30.2**	**46.6**	**45.0**	**6.3**	**2.4**	**6.3**	**12.7**	**2.8**	—	**12.2**	**25.9**	—
83	Aug. 8	18.94	3.65	4.25	8.25	0.85	4.10	5.25	8.80	8.65	1.15	0.40	0.98	2.25	0.50	—	2.30	4.90	70
		62	**19.3**	**22.4**	**43.6**	**4.5**	**21.6**	**27.7**	**46.5**	**45.7**	**6.1**	**2.1**	**5.2**	**11.9**	**2.6**	—	**12.1**	**25.9**	—
95	Aug. 10	19.10	3.60	3.95	8.70	0.80	3.90	5.00	8.80	8.60	1.30	0.40	0.80	2.35	0.55	—	2.20	4.80	66
		63	**18.8**	**20.7**	**45.5**	**4.2**	**20.4**	**26.2**	**46.1**	**45.0**	**6.8**	**2.1**	**4.2**	**12.3**	**2.9**	—	**11.5**	**25.1**	—
262	Sept. 10	19.20	3.65	4.00	8.40	0.80	4.00	5.10	8.40	8.40	1.30	0.40	1.20	2.35	0.57	—	2.30	5.00	58
		63	**19.0**	**20.8**	**43.7**	**4.2**	**20.8**	**26.6**	**43.7**	**43.7**	**6.8**	**2.1**	**6.2**	**12.2**	**3.0**	—	**12.0**	**26.0**	—
40	July 28	19.30	3.70	4.30	8.65	1.10	4.70	5.40	8.90	9.10	1.40	0.35	0.60	2.40	0.60	—	2.40	4.75	76
		64	**19.2**	**22.3**	**44.8**	**5.7**	**24.4**	**28.0**	**46.1**	**47.1**	**7.3**	**1.8**	**3.1**	**12.4**	**3.1**	—	**12.4**	**24.6**	—
258	Sept. 10	19.57	3.87	4.25	8.50	0.85	4.20	5.30	8.70	8.50	1.30	0.50	1.30	2.45	0.65	—	2.35	5.05	68
		64	**19.8**	**21.7**	**43.4**	**4.3**	**21.5**	**27.1**	**44.5**	**43.4**	**6.6**	**2.6**	**6.6**	**12.5**	**3.3**	—	**12.0**	**25.8**	—
295	Sept. 17	19.64	3.85	4.20	8.20	0.85	4.30	5.20	8.60	8.60	1.30	0.45	1.00	2.25	0.55	—	2.15	5.15	62
		64	**19.6**	**21.4**	**41.8**	**4.3**	**21.9**	**26.5**	**43.8**	**43.8**	**6.7**	**2.3**	**5.1**	**11.5**	**2.8**	—	**10.9**	**26.2**	—
289	Sept. 17	19.73	3.60	4.15	8.90	0.85	4.30	5.50	8.30	8.30	1.10	0.42	1.20	2.40	0.57	—	2.15	5.20	64
		65	**18.2**	**21.0**	**45.1**	**4.3**	**21.8**	**27.9**	**42.1**	**42.1**	**5.6**	**2.1**	**6.1**	**12.2**	**2.9**	—	**10.9**	**26.4**	—
15	July 22	19.80	3.50	3.90	8.00	0.85	4.65	5.35	8.90	8.90	1.30	0.41	0.90	2.50	0.55	—	2.20	5.00	64
		65	**17.7**	**19.7**	**40.4**	**4.3**	**23.5**	**27.0**	**44.9**	**44.9**	**6.6**	**2.1**	**4.5**	**12.6**	**2.8**	—	**11.1**	**25.3**	—
275	Sept. 14	19.92	3.60	4.00	8.50	0.80	4.50	5.80	8.90	9.20	1.10	0.43	0.90	2.25	0.60	—	2.17	4.85	68
		65	**18.1**	**20.1**	**42.7**	**4.0**	**22.6**	**29.1**	**44.7**	**46.2**	**5.5**	**2.2**	**4.5**	**11.3**	**3.0**	—	**10.9**	**24.3**	—

II. Northern Pacific, Females, 1952

Whale No.	Date killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22	29
285	Sept. 15	17.60	3.25	3.50	7.60	0.80	4.00	5.00	7.86	7.70	0.60	0.35	1.00	2.15	0.50	—	2.00	4.40	60
		58	**18.5**	**19.9**	**43.2**	**4.5**	**22.7**	**28.4**	**44.7**	**43.7**	**3.4**	**2.0**	**5.7**	**12.2**	**2.8**	—	**11.4**	**25.0**	—
277	Sept. 14	17.75	3.18	3.80	7.45	0.80	4.20	5.20	8.00	7.90	0.40	0.40	0.90	2.20	0.50	—	2.27	4.75	68
		58	**17.9**	**21.4**	**42.0**	**4.5**	**23.7**	**29.3**	**45.1**	**44.5**	**2.3**	**2.3**	**5.1**	**12.4**	**2.8**	—	**12.8**	**26.8**	—
287	Sept. 16	18.18	3.60	4.00	7.55	0.80	4.00	5.10	8.20	8.50	0.60	0.47	1.20	2.10	0.59	—	2.20	4.75	50
		60	**19.8**	**22.0**	**41.5**	**4.4**	**22.0**	**28.1**	**45.1**	**46.8**	**3.3**	**2.6**	**6.6**	**11.6**	**3.2**	—	**12.1**	**26.1**	—
264	Sept. 10	18.76	3.60	4.05	7.60	0.80	4.35	5.23	8.25	8.25	0.55	0.42	0.95	2.12	0.56	—	2.10	4.95	66
		62	**19.2**	**21.6**	**40.5**	**4.3**	**23.2**	**27.9**	**44.0**	**44.0**	**2.9**	**2.2**	**5.1**	**11.3**	**3.0**	—	**11.2**	**26.4**	—
79	Aug. 8	18.94	3.70	4.10	7.65	0.85	4.15	5.10	8.70	8.50	0.60	0.45	0.85	2.20	0.55	—	2.20	4.95	68
		62	**19.5**	**21.6**	**40.4**	**4.5**	**21.9**	**26.9**	**45.9**	**44.9**	**3.2**	**2.4**	**4.5**	**11.6**	**2.9**	—	**11.6**	**26.1**	—
274	Sept. 14	19.34	3.70	4.50	8.20	0.80	4.10	5.00	8.30	8.30	0.50	0.42	1.10	2.20	0.58	—	2.35	5.25	84
		63	**19.1**	**23.3**	**42.4**	**4.1**	**21.2**	**25.9**	**42.9**	**42.9**	**2.6**	**2.2**	**5.7**	**11.4**	**3.0**	--	**12.2**	**27.1**	—
257	Sept. 9	19.39	3.40	4.20	8.00	0.85	4.20	5.10	8.10	8.00	0.60	0.50	0.70	2.25	0.54	—	2.35	4.95	66
		64	**17.5**	**21.7**	**41.3**	**4.4**	**21.7**	**26.3**	**41.8**	**41.3**	**3.1**	**2.6**	**3.6**	**11.6**	**2.8**	—	**12.1**	**25.5**	—
49	July 31	19.40	3.40	4.00	8.20	0.80	4.20	5.50	8.40	8.10	0.60	0.50	0.70	2.25	0.57	—	2.25	5.00	64
		64	**17.5**	**20.6**	**42.3**	**4.1**	**21.6**	**28.4**	**43.3**	**41.8**	**3.1**	**2.6**	**3.6**	**11.6**	**2.9**	—	**11.6**	**25.8**	—
282	Sept. 14	19.40	3.65	4.10	8.60	0.85	4.30	5.20	8.70	8.70	0.60	0.45	1.00	2.40	0.56	—	2.40	5.00	64
		64	**18.8**	**21.1**	**44.3**	**4.4**	**22.2**	**26.8**	**44.8**	**44.8**	**3.1**	**2.3**	**5.2**	**12.4**	**2.9**	—	**12.4**	**25.8**	—
286	Sept. 15	19.50	3.65	4.15	8.10	0.85	4.30	5.00	9.00	8.80	0.80	0.45	1.00	2.26	0.56	—	2.30	5.06	66
		64	**18.7**	**21.3**	**41.5**	**4.4**	**22.1**	**25.6**	**46.2**	**45.1**	**4.1**	**2.3**	**5.1**	**11.6**	**2.9**	—	**11.8**	**25.9**	—
34	July 27	19.60	3.80	4.30	8.40	0.80	4.60	5.20	8.20	8.40	0.50	0.55	1.30	2.55	0.59	—	2.35	5.30	72
		65	**19.4**	**21.9**	**42.9**	**4.1**	**23.5**	**26.5**	**41.8**	**42.9**	**2.6**	**2.8**	**6.6**	**13.0**	**3.0**	—	**12.0**	**27.0**	—
168	Aug. 25	20.13	4.05	4.50	8.60	0.85	4.60	5.60	9.00	9.00	0.60	0.50	1.20	2.25	0.57	—	2.38	5.45	70
		66	**20.1**	**22.4**	**42.7**	**4.2**	**22.9**	**27.8**	**44.7**	**44.7**	**3.0**	**2.5**	**6.0**	**11.2**	**2.8**	—	**11.8**	**27.1**	—
138	Aug. 21	20.23	3.80	4.25	8.50	1.00	4.70	5.60	9.30	9.20	0.60	0.45	0.70	2.70	0.60	—	2.30	5.20	68
		66	**18.8**	**21.0**	**42.0**	**4.9**	**23.2**	**27.7**	**46.0**	**45.5**	**3.0**	**2.2**	**3.5**	**13.3**	**3.0**	—	**11.4**	**25.7**	—
273	Sept. 14	20.37	3.85	4.40	8.85	0.85	4.90	5.60	9.10	9.30	0.70	0.45	1.20	2.35	0.55	—	2.35	5.15	86
		67	**18.9**	**21.6**	**43.4**	**4.2**	**24.1**	**27.5**	**44.7**	**45.7**	**3.4**	**2.2**	**5.9**	**11.5**	**2.7**	—	**11.5**	**25.3**	—
47	July 29	20.40	3.60	4.10	8.10	0.80	4.50	5.70	9.20	9.40	0.70	—	0.70	2.15	0.52	—	2.15	5.00	60
		67	**17.6**	**20.1**	**39.7**	**3.9**	**22.1**	**27.9**	**45.1**	**46.1**	**3.4**	—	**3.4**	**10.5**	**2.5**	—	**10.5**	**24.5**	—

III. Adjacent Waters of Japan, Males, 1950~1951

Area	Company	Whale No.	killed Date	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22	29
H	K	67	Aug. 28	15.50	2.48	3.00	—	0.66	3.70	4.50	7.80	7.60	0.70	0.33	0.70	1.70	0.47	3.68	1.70	3.58	57
			1950	**51**	**16.0**	**19.4**	—	**4.3**	**23.9**	**29.0**	**50.3**	**49.0**	**4.5**	**2.1**	**4.5**	**11.0**	**3.0**	**23.7**	**11.0**	**23.1**	—
H	N	51	May 21	15.54	2.68	3.00	6.50	0.40	3.80	4.60	7.20	7.10	1.00	0.40	0.80	2.09	0.40	—	1.80	3.80	—
			1951	**51**	**17.2**	**19.3**	**41.8**	**2.6**	**24.5**	**29.6**	**46.3**	**45.7**	**6.4**	**2.6**	**5.2**	**13.5**	**2.6**	—	**11.6**	**24.5**	—
H	T	148		15.60	2.70	3.20	6.70	0.73	4.00	4.80	7.80	7.50	1.10	—	0.90	1.75	0.41	—	1.75	3.85	—
			1950	**51**	**17.3**	**20.5**	**42.9**	**4.7**	**25.6**	**30.8**	**50.0**	**48.1**	**7.1**	—	**5.8**	**11.2**	**2.6**	—	**11.2**	**24.7**	—
H	T	252		15.80	2.72	3.30	6.60	0.70	4.10	4.85	7.70	7.50	1.00	0.45	0.95	1.95	0.45	—	1.85	3.80	—
			1950	**52**	**17.2**	**20.9**	**41.8**	**4.4**	**26.0**	**30.7**	**48.7**	**47.5**	**6.3**	**2.8**	**6.0**	**12.3**	**2.8**	—	**11.7**	**24.1**	—
S	N	77	July 2	15.85	2.60	2.95	5.95	0.78	3.70	4.72	7.80	7.55	1.25	0.40	0.95	2.00	0.40	3.65	1.60	3.55	—
			1951	**52**	**16.4**	**18.6**	**37.5**	**4.9**	**23.3**	**29.8**	**49.2**	**47.6**	**7.9**	**2.5**	**6.0**	**12.6**	**2.5**	**23.0**	**10.1**	**22.4**	—
H	T	149		16.20	2.85	3.60	6.10	0.74	—	4.85	8.10	7.80	1.50	0.55	1.00	1.72	0.41	—	1.78	3.70	76
			1950	**53**	**17.6**	**22.2**	**37.7**	**4.6**	—	**29.9**	**50.0**	**48.1**	**9.3**	**3.4**	**6.2**	**10.6**	**2.5**	—	**11.0**	**22.8**	—
H	N	64	June 11	17.07	3.32	3.60	7.40	0.67	4.30	5.10	8.20	7.80	1.70	0.43	0.67	2.27	0.57	—	2.20	4.20	—
			1951	**56**	**19.4**	**21.1**	**43.6**	**3.9**	**25.2**	**29.9**	**48.0**	**45.7**	**6.4**	**2.5**	**3.9**	**13.3**	**3.3**	—	**12.8**	**24.6**	—
S	N	7	June 21	17.07	3.15	3.47	6.89	—	4.27	4.82	7.87	—	1.28	0.49	0.61	1.58	0.35	—	1.95	4.20	—
			1951	**56**	**18.5**	**20.3**	**40.3**	—	**25.0**	**28.2**	**46.1**	—	**7.5**	**2.9**	**3.6**	**9.3**	**2.1**	—	**11.4**	**24.6**	—
H	T	156		17.70	3.10	3.40	6.70	0.73	4.40	5.10	8.30	8.10	1.30	0.36	0.78	1.95	0.50	—	1.95	4.10	68
			1950	**58**	**17.5**	**19.2**	**37.9**	**4.1**	**24.9**	**28.8**	**46.9**	**45.8**	**7.3**	**2.0**	**4.4**	**11.0**	**2.8**	—	**11.0**	**23.2**	—
S	N	13	May 15	18.29	3.20	—	7.90	—	4.30	5.20	8.15	7.90	1.10	0.53	1.00	2.55	0.57	—	2.20	4.82	—
			1951	**60**	**17.5**	—	**43.2**	—	**23.5**	**28.4**	**44.6**	**43.2**	**6.0**	**2.9**	**5.5**	**13.9**	**3.1**	—	**12.0**	**26.4**	—
H	N	57	June 4	18.59	3.42	3.90	—	0.80	4.30	5.30	8.40	8.10	1.40	0.45	0.70	—	—	—	—	—	—
			1951	**61**	**18.4**	**21.0**	—	**4.3**	**23.1**	**28.5**	**45.2**	**43.6**	**7.5**	**2.4**	**3.8**	—	—	—	—	—	—
H	N	59	June 4	18.59	3.50	4.10	8.10	0.60	4.70	5.30	8.40	—	1.30	0.50	0.80	2.40	0.60	—	2.10	5.00	—
			1951	**61**	**18.8**	**22.1**	**43.6**	**3.2**	**25.3**	**28.5**	**45.2**	—	**7.0**	**2.7**	**4.3**	**12.9**	**3.2**	—	**11.3**	**26.9**	—
H	K	54	Aug. 23	18.70	3.54	4.07	7.60	0.90	4.69	5.15	8.60	8.30	1.25	0.40	0.81	2.15	0.60	—	2.20	4.94	57
			1950	**61**	**18.9**	**21.8**	**40.6**	**4.8**	**25.1**	**27.5**	**46.0**	**44.4**	**6.7**	**2.1**	**4.3**	**11.5**	**3.2**	—	**11.8**	**26.4**	—
H	T	150		18.85	3.50	4.00	8.00	0.80	4.90	5.10	8.40	8.20	1.10	0.41	0.79	2.22	0.51	—	2.10	4.85	64
			1950	**62**	**18.6**	**21.2**	**42.4**	**4.2**	**26.0**	**27.1**	**44.6**	**43.5**	**5.8**	**2.2**	**4.2**	**11.8**	**2.7**	—	**11.1**	**25.7**	—
S	N	2	May 30	19.20	3.45	4.55	7.79	0.79	4.73	5.33	8.73	8.42	1.35	0.36	1.00	2.00	0.53	—	2.30	5.03	—
			1951	**63**	**18.0**	**23.8**	**40.5**	**4.1**	**24.6**	**27.8**	**45.5**	**43.9**	**7.0**	**1.9**	**5.2**	**10.4**	**2.8**	—	**12.0**	**26.2**	—

III. Adjacent Waters of Japan, Females, 1950~51

Area	Company	Whale No.	Date killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22	29
H	N	67	June 16	15.47	2.70	2.88	5.75	0.72	—	4.60	7.30	6.90	0.40	0.40	0.65	1.95	0.43	—	1.60	3.65	—
			1951	51	**17.5**	**18.6**	**37.2**	**4.7**	—	**29.7**	**47.2**	**44.6**	**2.6**	**2.6**	**4.2**	**12.6**	**2.8**	—	**10.3**	**23.6**	—
H	K	67		15.50	2.75	3.00	5.90	0.73	3.50	4.70	7.40	7.10	0.43	0.42	0.75	1.90	0.42	—	1.70	3.58	—
			1950	51	**17.7**	**19.4**	**38.1**	**4.1**	**22.6**	**30.3**	**47.7**	**45.8**	**2.8**	**2.7**	**4.8**	**12.3**	**2.7**	—	**11.0**	**23.1**	—
H	T	121	June 12	15.54	2.72	3.15	6.00	0.72	3.60	4.60	7.25	7.33	0.47	0.30	0.67	1.69	0.43	—	—	—	—
			1951	51	**17.5**	**20.3**	**38.6**	**4.6**	**23.2**	**29.6**	**46.7**	**47.2**	**3.0**	**1.9**	**4.3**	**10.9**	**2.8**	—	—	—	—
H	T	192		15.90	2.75	3.45	6.01	—	4.10	4.65	8.20	7.70	0.45	0.39	0.95	1.80	0.44	—	1.70	3.84	—
			1950	52	**17.3**	**21.7**	**37.8**	—	**25.8**	**29.2**	**51.6**	**48.4**	**2.8**	**2.4**	**6.0**	**11.3**	**2.8**	—	**10.7**	**24.2**	—
H	T	241		15.80	2.73	3.00	6.80	0.73	4.21	4.61	7.34	7.14	0.43	0.30	0.88	1.70	0.44	—	1.65	3.89	—
			1950	52	**17.3**	**19.0**	**43.0**	**4.6**	**26.6**	**29.2**	**46.5**	**45.2**	**2.7**	**1.9**	**5.6**	**10.8**	**2.8**	—	**10.4**	**24.6**	—
S	T	33	June 4	16.15	2.60	3.15	6.20	0.75	4.10	—	—	—	—	—	—	—	—	—	1.65	3.65	—
			1951	53	**16.1**	**19.5**	**38.4**	**4.6**	**25.4**	—	—	—	—	—	—	—	—	—	**10.2**	**22.6**	—
H	T	287	Sept. 2	17.37	3.48	3.65	7.20	0.82	3.95	4.88	8.08	7.90	0.38	—	1.00	1.80	0.51	—	2.07	4.55	—
			1950	57	**20.0**	**21.0**	**41.5**	**4.7**	**22.7**	**28.1**	**46.5**	**45.5**	**2.2**	—	**5.8**	**10.4**	**2.9**	—	**11.9**	**26.2**	—
H	N	299		17.40	3.34	3.65	7.50	0.85	4.20	5.20	8.20	8.00	0.50	0.43	0.77	2.05	0.52	—	2.00	4.43	—
			1950	57	**19.2**	**21.0**	**43.1**	**4.9**	**24.1**	**29.9**	**47.1**	**46.0**	**2.9**	**2.5**	**4.4**	**11.8**	**3.0**	—	**11.5**	**25.5**	—
H	T	159		17.60	3.10	3.30	7.00	0.65	4.05	5.50	8.60	8.20	0.50	0.34	0.80	1.95	0.51	—	2.10	4.20	60
			1950	58	**17.6**	**18.7**	**39.8**	**3.7**	**23.0**	**31.2**	**48.9**	**46.6**	**2.8**	**1.9**	**4.5**	**11.1**	**2.9**	—	**11.9**	**23.9**	—
H	T	162		17.90	3.50	3.70	7.20	0.74	4.60	5.00	8.04	7.90	0.54	0.47	1.05	1.97	0.51	—	2.18	4.65	64
			1950	59	**19.6**	**20.7**	**40.2**	**4.1**	**25.7**	**27.9**	**44.9**	**44.1**	**3.0**	**2.6**	**5.9**	**11.0**	**2.8**	—	**12.2**	**26.0**	—
S	T	30	May 30	17.98	3.40	3.75	7.20	0.85	4.10	5.10	8.40	8.10	0.50	0.42	0.90	2.20	0.55	—	2.10	4.60	—
			1951	59	**19.0**	**21.0**	**40.2**	**4.8**	**22.9**	**28.5**	**47.0**	**45.3**	**2.8**	**2.3**	**5.0**	**12.3**	**3.1**	—	**11.7**	**25.7**	—
H	T	225		18.36	3.35	3.55	6.80	0.87	4.30	5.15	9.00	8.55	0.50	0.42	0.80	2.30	0.58	—	2.00	4.50	52
			1950	60	**18.2**	**19.3**	**37.0**	**4.7**	**23.4**	**28.0**	**49.0**	**46.6**	**2.7**	**2.3**	**4.4**	**12.5**	**3.2**	—	**10.9**	**24.5**	—
H	T	244		18.85	3.35	3.78	7.80	0.89	4.60	5.40	8.00	—	0.42	0.45	0.91	2.37	0.59	—	2.25	4.67	—
			1950	62	**17.8**	**20.1**	**41.4**	**4.7**	**24.4**	**28.6**	**42.4**	—	**2.2**	**2.4**	**4.8**	**12.6**	**3.1**	—	**11.9**	**24.8**	—
H	N	392		18.90	3.45	3.80	7.50	0.60	4.25	5.35	8.55	8.25	0.40	0.40	0.90	2.30	0.55	—	2.40	4.85	—
			1950	62	**18.3**	**20.1**	**39.7**	**3.2**	**22.5**	**28.3**	**45.2**	**43.7**	**2.1**	**2.1**	**4.8**	**12.2**	**2.9**	—	**12.7**	**25.7**	—
H	T	246		19.15	3.70	4.40	7.70	0.95	4.70	5.60	9.30	9.10	0.70	0.53	1.00	2.35	0.57	—	2.60	4.93	48
			1950	63	**19.3**	**23.0**	**40.2**	**5.0**	**24.5**	**29.2**	**48.6**	**47.5**	**3.7**	**2.8**	**5.2**	**12.3**	**3.0**	—	**13.6**	**25.7**	—

III. Adjacent Waters of Japan, Females, 1950~51 (cont.)

Area	Company	Whale No.	Date killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22	29
H	T	106	May 22	19.51	3.60	4.30	7.60	0.98	4.15	5.70	9.10	9.15	0.35	0.36	0.96	2.38	0.62	—	—	—	—
			1951	64	**18.5**	**22.0**	**39.0**	**5.0**	**21.3**	**29.2**	**46.6**	**46.9**	**1.8**	**1.8**	**4.9**	**12.2**	**3.2**	—	—	—	—
S	T	29	May 30	19.51	3.80	4.10	7.75	0.90	4.50	5.40	8.90	8.80	0.60	0.29	0.60	2.20	0.60	—	2.20	5.00	—
			1951	64	**19.5**	**21.0**	**39.7**	**4.6**	**23.1**	**27.7**	**45.6**	**45.1**	**3.1**	**1.5**	**3.1**	**11.3**	**3.1**	—	**11.3**	**25.6**	—
S	T	32	June 2	19.51	3.70	4.10	7.60	0.90	—	5.60	9.20	8.90	0.50	0.35	0.95	2.30	0.55	—	2.00	4.90	—
			1951	64	**19.0**	**21.0**	**39.0**	**4.6**	—	**28.7**	**47.2**	**45.6**	**2.6**	**1.8**	**4.9**	**11.8**	**2.8**	—	**10.3**	**25.1**	—
H	T	154		19.80	3.75	4.20	8.10	0.83	4.55	5.90	9.10	8.90	0.20	0.36	0.70	2.24	0.55	—	2.20	5.10	—
			1950	65	**18.9**	**21.2**	**40.9**	**4.2**	**23.0**	**29.8**	**46.0**	**44.9**	**1.0**	**1.8**	**3.5**	**11.3**	**2.8**	—	**11.1**	**25.8**	—
H	N	89	June 27	19.99	3.90	4.10	8.30	1.00	3.90	5.45	9.10	8.80	0.55	0.60	—	2.40	0.60	—	2.25	5.15	—
			1951	66	**19.5**	**20.5**	**41.5**	**5.0**	**19.5**	**27.3**	**45.5**	**44.0**	**2.8**	**3.0**	—	**12.0**	**3.0**	—	**11.3**	**25.8**	—
S	T	31	June 1	20.12	3.95	4.15	8.10	0.85	4.40	5.80	9.45	9.10	0.50	0.44	1.05	2.30	0.58	—	2.20	5.20	—
			1951	66	**19.6**	**20.6**	**40.3**	**4.2**	**21.9**	**28.8**	**47.0**	**45.2**	**2.5**	**2.2**	**5.2**	**11.4**	**2.9**	—	**10.9**	**25.8**	—
H	N	66	June 11	21.64	4.10	5.20	9.10	0.80	4.50	5.97	—	9.46	0.40	0.41	0.68	2.44	0.54	—	2.20	5.60	—
			1951	71	**18.9**	**24.0**	**42.1**	**3.7**	**20.8**	**27.6**	—	**43.7**	**1.8**	**1.9**	**3.1**	**11.3**	**2.5**	—	**10.9**	**27.3**	—

IV. Antarctic, Males, 1948～1951

Company	Whale No.	Date killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22
N	39		18.06	—	3.85	7.50	0.90	4.10	5.00	8.05	7.07	1.44	0.35	0.58	2.10	0.50	—	—	—
		1948～49	59	—	**21.3**	**41.5**	**4.9**	**22.7**	**27.7**	**44.6**	**39.1**	**8.0**	**1.9**	**3.2**	**11.6**	**2.8**	—	—	—
N	25		19.20	3.50	3.70	7.75	0.80	4.50	5.55	8.75	8.65	1.39	0.45	0.85	2.25	0.53	—	2.10	—
		1948～49	63	**18.2**	**19.7**	**40.4**	**4.4**	**23.4**	**28.9**	**45.6**	**45.1**	**7.2**	**2.3**	**4.4**	**11.7**	**2.8**	—	**10.9**	—
N	158		19.50	3.30	3.78	7.90	0.85	4.60	5.35	9.25	8.60	1.55	0.43	1.16	2.52	0.48	4.80	—	—
		1948～49	64	**16.9**	**19.4**	**40.5**	**4.4**	**23.6**	**27.4**	**47.4**	**44.1**	**7.9**	**2.2**	**5.9**	**12.9**	**2.5**	**24.6**	—	—
T	927		19.68	3.66	4.04	8.31	0.97	4.22	5.41	8.76	7.80	1.24	0.38	1.32	—	0.56	—	—	—
		1948～49	65	**18.6**	**20.5**	**42.2**	**4.9**	**21.4**	**27.5**	**44.5**	**39.6**	**6.3**	**1.9**	**6.7**	—	**2.8**	—	—	—
N	259	Jan. 18	20.40	4.08	4.36	8.82	0.97	4.50	5.20	8.46	8.38	1.50	0.44	0.95	2.41	0.58	5.47	2.32	5.42
		1950	67	**20.0**	**21.4**	**43.2**	**4.8**	**22.1**	**25.5**	**41.5**	**41.1**	**7.4**	**2.2**	**4.7**	**11.8**	**2.8**	**26.8**	**11.4**	**26.6**
N	219		20.42	3.80	4.05	8.40	0.85	4.86	5.95	9.25	8.90	1.40	0.50	1.10	2.51	0.54	—	2.34	—
		1948～49	67	**18.6**	**19.8**	**41.1**	**4.2**	**23.8**	**29.1**	**45.3**	**43.6**	**6.9**	**2.4**	**5.4**	**12.3**	**2.6**	—	**11.5**	—
T	487	Jan. 15	20.42	3.73	4.12	7.98	0.94	4.12	5.54	9.14	8.53	1.35	0.48	1.27	2.59	0.52	5.38	2.25	5.35
		1951	67	**18.2**	**20.2**	**39.0**	**4.6**	**20.1**	**29.1**	**44.7**	**41.7**	**6.6**	**2.3**	**6.2**	**12.7**	**2.5**	**26.3**	**11.0**	**26.2**
N	417	Jan. 22	20.45	3.85	4.15	7.70	0.85	—	—	9.50	9.25	1.55	—	—	2.10	0.54	—	2.10	5.10
		1951	67	**18.8**	**20.3**	**37.7**	**4.2**	—	—	**46.5**	**45.2**	**7.6**	—	—	**10.2**	**2.6**	—	**10.2**	**24.9**
N	127		20.53	4.05	4.25	8.65	0.85	4.70	5.70	8.75	8.70	1.45	0.40	1.55	2.55	0.58	—	2.05	—
		1948～49	67	**19.7**	**20.7**	**42.1**	**4.1**	**22.8**	**27.8**	**42.6**	**42.4**	**7.1**	**1.9**	**7.5**	**12.4**	**2.8**	—	**10.0**	—

IV. Antarctic, Females, 1948～1951

Company	Whale No.	Date killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22
T	1207	Feb. 27	17.40	3.25	3.45	6.76	0.81	3.76	4.90	7.63	7.50	0.38	0.47	1.31	1.83	0.46	—	1.84	4.50
		1951	57	**18.7**	**19.8**	**38.9**	**4.7**	**21.6**	**28.2**	**43.9**	**43.2**	**2.2**	**2.7**	**7.5**	**10.5**	**2.6**	—	**10.6**	**25.9**
T	85		18.54	—	3.68	7.52	0.94	4.39	5.26	8.13	—	—	0.46	1.02	—	0.51	—	1.83	—
		1948～49	61	—	**19.8**	**40.6**	**5.1**	**23.7**	**28.4**	**43.9**	—	—	**2.5**	**5.5**	—	**2.8**	—	**9.9**	—
N	116	Jan. 3	20.18	3.67	3.93	8.05	0.93	4.90	6.00	9.30	8.85	0.60	0.48	1.23	2.15	0.54	—	—	4.91
		1950	66	**18.2**	**19.5**	**39.9**	**4.6**	**24.3**	**29.7**	**46.1**	**43.9**	**3.0**	**2.4**	**6.1**	**10.7**	**2.7**	—	—	**24.3**

IV. Antarctic, Females, 1948~1951 (cont.)

Company	Whale No.	Date, killed	1	3	5	6	7	8	10	11	12	13	14	15	17	19	20	21	22
T	507	Jan. 17	20.32	4.00	4.27	7.91	0.94	4.45	5.70	9.11	8.91	0.54	0.41	1.92	2.35	0.61	—	2.20	5.20
		1951	67	**19.7**	**21.0**	**38.9**	**4.6**	**21.9**	**28.0**	**47.8**	**43.8**	**2.7**	**2.0**	**9.4**	**11.6**	**3.0**	—	**10.8**	**25.5**
N	919	Mar. 7	20.60	3.95	4.40	7.70	—	5.00	5.75	8.90	8.70	0.60	0.60	1.20	2.70	0.54	5.55	2.27	5.50
		1951	68	**19.2**	**21.4**	**37.4**	—	**24.3**	**27.9**	**43.2**	**42.2**	**2.9**	**2.9**	**5.8**	**13.1**	**2.6**	**26.9**	**11.0**	**26.7**
N	15		20.62	3.95	4.25	8.60	0.74	4.52	5.55	8.96	9.00	0.65	0.44	1.20	2.75	0.59	—	2.35	5.25
		1948~49	68	**19.2**	**20.6**	**41.7**	**3.6**	**21.9**	**26.9**	**43.5**	**43.6**	**3.2**	**2.1**	**5.8**	**13.3**	**2.9**	—	**11.4**	**25.5**
N	287	Jan. 20	21.09	4.13	4.49	8.68	0.91	4.35	6.05	9.10	8.80	0.50	0.47	1.42	2.59	0.55	5.60	2.42	5.57
		1950	69	**19.6**	**21.3**	**41.2**	**4.3**	**20.6**	**28.7**	**43.1**	**41.7**	**2.4**	**2.2**	**6.7**	**12.3**	**2.6**	**26.6**	**11.5**	**26.4**
N	276	Jan. 18	21.20	4.21	4.39	8.80	0.94	4.70	5.66	9.07	8.70	0.60	0.56	1.77	2.56	0.56	5.41	2.36	5.37
		1950	70	**19.9**	**20.7**	**41.5**	**4.4**	**22.2**	**26.7**	**42.8**	**41.0**	**2.8**	**2.6**	**8.3**	**12.1**	**2.6**	**25.5**	**11.1**	**25.3**
T	795		21.41	4.34	4.47	8.94	0.99	4.65	5.74	9.14	—	0.66	0.48	0.79	—	0.63	—	2.84	—
		1948~49	70	**20.3**	**20.9**	**41.8**	**4.6**	**21.7**	**26.8**	**42.7**	—	**3.1**	**2.2**	**3.7**	—	**2.9**	—	**13.3**	—
N	264		21.45	3.80	4.48	8.60	0.92	5.25	5.90	10.0	9.25	0.60	0.75	0.92	2.70	0.54	5.55	—	—
		1948~49	70	**17.7**	**20.9**	**40.1**	**4.3**	**24.5**	**27.5**	**46.6**	**43.1**	**2.8**	**2.5**	**4.3**	**12.6**	**2.5**	**25.9**	—	—
N	540		21.50	3.95	4.40	8.90	0.95	5.10	6.10	9.70	9.40	0.70	0.40	1.35	2.40	0.58	—	2.08	5.20
		1948~49	71	**18.4**	**20.5**	**41.4**	**4.4**	**23.7**	**28.4**	**45.1**	**43.7**	**3.3**	**1.9**	**6.3**	**11.2**	**2.7**	—	**9.7**	**24.2**
T	86		21.51	4.27	4.72	9.24	1.07	—	6.02	9.96	9.01	0.63	0.41	1.24	—	0.53	—	2.54	—
		1948~49	71	**19.9**	**21.9**	**43.0**	**5.0**	—	**28.0**	**46.3**	**41.9**	**2.9**	**1.9**	**5.8**	—	**2.5**	—	**11.8**	—
N	68		22.25	4.45	4.80	9.45	0.95	5.15	6.15	9.85	9.65	0.65	0.40	1.15	2.75	0.65	—	2.45	5.60
		1948~49	73	**20.0**	**21.6**	**42.5**	**4.3**	**23.1**	**27.6**	**44.3**	**43.4**	**2.9**	**1.8**	**5.2**	**12.4**	**2.9**	—	**11.0**	**25.2**
N	21		22.30	4.20	4.80	9.20	0.98	5.28	6.10	9.85	9.40	0.63	0.45	1.15	2.52	0.59	—	2.20	—
		1948~49	73	**18.8**	**21.5**	**41.3**	**4.4**	**23.7**	**27.4**	**44.2**	**42.2**	**2.8.**	**2.0**	**5.2**	**11.3**	**2.6**	—	**9.9**	—
N	105		22.65	4.90	5.10	9.90	0.98	5.15	5.90	9.25	9.60	0.60	0.55	0.85	2.78	0.68	—	2.54	—
		1948~49	74	**21.6**	**22.5**	**43.7**	**4.3**	**22.7**	**26.0**	**40.8**	**42.4**	**2.6**	**2.4**	**3.8**	**12.3**	**3.0**	—	**11.2**	—
N	198	Jan. 13	22.67	4.79	4.72	—	1.05	4.65	6.30	9.80	9.55	0.60	0.67	2.28	2.72	0.62	—	2.51	5.90
		1950	74	**21.1**	**20.8**	—	**4.6**	**20.5**	**27.8**	**43.2**	**42.1**	**2.6**	**3.0**	**10.1**	**12.0**	**2.7**	—	**11.1**	**26.4**
N	289	Jan. 20	22.70	4.48	4.83	9.69	0.95	4.80	6.20	9.70	9.60	0.55	0.58	1.35	2.46	0.63	5.86	2.44	5.83
		1950	74	**19.7**	**21.3**	**42.7**	**4.2**	**21.1**	**27.3**	**42.7**	**42.3**	**2.4**	**2.6**	**5.9**	**10.8**	**2.8**	**25.8**	**10.7**	**25.7**
T	783		23.04	4.70	4.95	9.91	1.09	5.18	6.40	10.16	—	0.31	0.48	1.19	—	—	—	2.21	—
		1948~49	76	**20.4**	**21.5**	**43.0**	**4.7**	**22.5**	**27.8**	**44.1**	—	**3.1**	**2.1**	**5.2**	—	—	—	**9.6**	—

Appendix B

Measurements of Skull Proportions of the Fin Whales examined in the northern Pacific and Antarctic

Upper figures: actual value in metres
Lower figures: percentages against skull length

Measurement No. 22. Skull length, condyle to tip of premaxilla.
〃 〃 21. Greatest width of skull
〃 〃 24. Length of lower jaw
〃 〃 25. Tip of premaxilla to posterior end of pterygoid
〃 〃 26. Distance between both posterior ends of pterygoid
〃 〃 27. Length of rostrum
〃 〃 28. Width of rostrum at the base

I. Northern Pacific, Males, 1952

Whale No.	Body length in m. and ft.	22	21	24	25	26	27	28
135	17.28	4.60	2.05	4.50	4.65	1.65	3.30	1.30
	57		**44.6**	**97.8**	**101.0**	**35.8**	**71.7**	**28.3**
263	17.38	4.40	1.96	4.15	4.40	1.62	3.00	1.25
	57		**44.6**	**94.3**	**100.0**	**36.8**	**65.2**	**28.4**
281	17.60	4.60	2.15	4.50	4.65	1.70	3.30	1.30
	58		**46.7**	**97.8**	**101.1**	**37.0**	**71.7**	**28.3**
167	17.70	4.80	2.10	4.70	4.80	1.80	3.45	1.40
	58		**43.7**	**97.9**	**100.0**	**37.5**	**71.9**	**29.2**
169	17.70	4.20	2.00	4.20	4.20	1.70	3.00	1.30
	58		**47.6**	**100.0**	**100.0**	**40.5**	**71.4**	**31.0**
38	17.76	4.25	1.88	4.10	4.35	1.60	3.15	1.20
	58		**44.2**	**96.5**	**102.4**	**37.6**	**74.1**	**28.2**
261	18.05	4.75	2.20	4.45	4.70	1.85	3.20	1.35
	60		**46.3**	**93.7**	**98.9**	**38.9**	**67.4**	**28.4**
14	18.20	4.90	2.25	5.00	4.85	1.95	3.30	1.25
	60		**45.9**	**102.1**	**99.0**	**39.8**	**67.4**	**25.5**
170	18.30	4.70	2.20	4.50	4.60	1.80	3.30	1.46
	60		**46.8**	**95.8**	**97.9**	**38.3**	**70.2**	**31.1**
222	18.30	4.55	2.20	4.35	4.50	1.65	3.20	1.35
	60		**48.4**	**95.6**	**98.9**	**36.3**	**70.3**	**29.7**
259	18.54	4.90	2.15	4.85	4.85	1.80	3.10	1.35
	61		**43.9**	**99.0**	**99.0**	**36.7**	**63.3**	**27.6**
276	18.56	4.90	2.18	4.75	4.85	1.70	3.40	1.30
	61		**44.5**	**96.9**	**99.0**	**34.7**	**69.4**	**26.5**
113	18.61	4.50	2.10	4.50	4.45	1.60	3.10	1.32
	61		**46.7**	**100.0**	**98.9**	**35.6**	**68.9**	**29.3**
223	18.63	4.45	2.10	4.40	4.45	1.65	3.00	1.25
	61		**47.2**	**98.9**	**100.0**	**37.1**	**67.4**	**28.1**
288	18 70	4.70	2.15	4.58	4.75	1.85	3.35	1.25
	61		**45.8**	**97.5**	**101.1**	**39.4**	**71.3**	**26.6**
162	18.90	4.90	2.30	4.70	4.90	1.90	3.50	1.38
	62		**46.9**	**95.9**	**100.0**	**38.8**	**71.4**	**28.2**
83	18.94	4.90	2.30	4.80	4.75	1.75	3.40	1.35
	62		**46.9**	**98.0**	**96.9**	**35.7**	**69.4**	**27.6**
95	19.10	4.80	2.20	4.55	4.80	1.80	3.30	1.30
	63		**45.8**	**94.8**	**100.0**	**37.5**	**68.7**	**27.1**
262	19.20	5.00	2.30	4.90	5.00	1.80	3.50	1.30
	63		**46.0**	**98.0**	**100.0**	**36.0**	**70.0**	**26.0**
40	19.30	4.75	2.40	4.50	4.90	1.90	3.55	1.40
	64		**50.5**	**94.7**	**103.1**	**40.0**	**74.7**	**29.5**
258	19.57	5.05	2.35	5.00	5.10	1.85	3.60	1.42
	64		**46.5**	**99.0**	**101.0**	**36.6**	**71.3**	**28.1**
295	19.64	5.15	2.15	4.90	5.10	1.75	3.60	1.35
	64		**41.8**	**95.2**	**99.0**	**34.0**	**70.0**	**26.2**
289	19.73	5.20	2.15	5.15	5.23	1.95	3.70	1.30
	65		**41.3**	**99.0**	**100.6**	**37.5**	**71.2**	**25.0**

I. Northern Pacific, Males, 1952 (cont.)

Whale No.	Body length in m. and ft.	22	21	24	25	26	27	28
15	19.80	5.00	2.20	4.80	4.90	1.80	3.30	1.20
	65		**44.0**	**96.0**	**98.0**	**36.0**	**66.0**	**24.0**
275	19.92	4.85	2.17	4.70	4.85	1.70	3.40	1.20
	65		**44.7**	**96.9**	**100.0**	**35.1**	**70.1**	**25.2**

I. Northern Pacific, Females, 1952

Whale No.	No. of corp. lutea	Body length in m. and ft.	22	21	24	25	26	27	28
285	0	17.60	4.40	2.00	4.30	4.45	1.70	3.40	1.20
		58		**45.4**	**97.7**	**101.1**	**38.6**	**77.3**	**27.3**
277	0	17.75	4.75	2.27	4.55	4.75	1.75	3.35	1.18
		58		**47.8**	**95.8**	**100.0**	**36.8**	**70.5**	**24.8**
287	2	18.18	4.75	2.20	4.57	4.70	1.65	3.40	1.25
		60		**46.3**	**96.2**	**98.9**	**34.7**	**71.6**	**26.3**
264	0	18.76	4.95	2.10	4.75	4.90	1.70	3.40	1.30
		62		**42.4**	**96.0**	**99.0**	**34.3**	**68.7**	**26.3**
79	1	18.94	4.95	2.20	4.80	4.90	1.85	3.51	1.40
		62		**44.4**	**97.0**	**99.0**	**37.4**	**71.0**	**28.3**
274	3	19.34	5.25	2.35	5.20	5.20	1.95	3.80	1.35
		63		**44.8**	**99.1**	**99.1**	**37.2**	**72.4**	**25.7**
257	11	19.39	4.95	2.35	4.75	5.13	1.85	3.65	1.35
		64		**47.5**	**96.0**	**103.6**	**37.4**	**73.7**	**27.3**
49	0	19.40	5.00	2.25	4.90	5.00	1.65	3.30	1.25
		64		**45.0**	**98.0**	**100.0**	**33.0**	**66.0**	**25.0**
282	6	19.40	5.00	2.40	4.70	4.90	1.75	3.65	1.35
		64		**48.0**	**94.0**	**98.0**	**35.0**	**73.0**	**27.0**
286	3	19.50	5.06	2.30	4.90	4.95	1.95	3.60	1.30
		64		**45.5**	**96.8**	**97.8**	**38.5**	**71.1**	**25.7**
34	9	19.60	5.30	2.35	5.10	5.20	1.86	3.87	1.40
		65		**44.3**	**96.2**	**98.1**	**35.0**	**73.0**	**26.4**
168	18	20.13	5.45	2.38	5.30	5.40	1.85	3.90	1.50
		66		**43.7**	**97.3**	**99.1**	**34.0**	**71.6**	**27.5**
138	6	20.23	5.20	2.30	5.10	5.25	1.90	3.74	1.40
		66		**44.2**	**98.1**	**101.0**	**36.5**	**72.0**	**26.9**
273	3	20.37	5.15	2.35	5.00	5.15	1.95	3.65	1.25
		67		**45.6**	**97.1**	**100.0**	**37.9**	**70.9**	**24.3**
47	8	20.40	5.00	2.30	4.90	5.05	1.85	3.60	1.40
		67		**46.0**	**98.0**	**101.0**	**37.0**	**72.0**	**28.0**

II. Antarctic, Males, 1950~51

Whale No.	Body length in m. and ft.	22	21	24	25	26	27	28
963	19.83	5.20	2.39	5.20	5.16	1.83	3.60	1.42
	65		**46.0**	**100.0**	**99.2**	**33.3**	**69.2**	**27.3**
741	20.13	5.20	2.28	5.10	5.16	1.72	3.77	1.30
	66		**43.8**	**98.1**	**99.2**	**33.1**	**72.5**	**25.0**
747	20.44	5.26	2.19	5.30	5.20	1.78	3.78	1.30
	67		**41.6**	**100.8**	**98.9**	**33.8**	**71.9**	**24.7**
947	71.66	5.20	2.15	5.02	5.16	1.63	3.62	1.35
	71		**41.3**	**96.5**	**99.2**	**31.3**	**69.6**	**26.0**

II. Antarctic, Females, 1950~51

Whale No.	No. of corp. lutea	Body length in m. and ft.	22	21	24	25	26	27	28
840	5	20.74	5.10	2.14	4.98	5.09	1.69	3.67	1.36
		68		**42.0**	**97.7**	**99.8**	**33.1**	**72.0**	**26.7**
675	7	21.35	5.56	2.37	5.58	5.57	1.95	—	—
		70		**42.6**	**100.4**	**100.2**	**35.1**	—	—
749	18	21.35	5.80	2.58	5.74	5.74	1.94	4.20	1.60
		70		**44.5**	**99.0**	**99.0**	**33.4**	**72.4**	**27·6**
870	5	21.96	5.48	2.28	—	5.47	1.84	4.00	1.50
		72		**41.6**	—	**99.8**	**33.6**	**73.0**	**27.4**
841	10	22.27	5.72	2.48	5.72	5.72	1.97	4.23	1.55
		73		**43.4**	**100.0**	**100.0**	**34.4**	**73.9**	**27.1**
743	22	22.57	5.85	2.48	5.79	5.85	1.98	4.22	1.35
		74		**42.4**	**99.0**	**100.0**	**33.8**	**72.1**	**23.1**
964	17	22.57	5.94	2.50	5.70	6.02	2.05	4.30	1.43
		74		**42.1**	**96.0**	**101.3**	**34.5**	**72.4**	**24.1**

On the Sexual Maturity of the Sei Whale of the Bonin Waters

(Received March 6, 1953)

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Introduction

Since 1923 Japanese whalers have been operating in the Bonin Islands waters, and the land stations on Chichi-jima was the base of the operation prior to the World War II. As this land station has been lost as the result of the war, the whaling has been conducted under the floating factory system since the 1946 season, taking 300 to 400 whales per season (Fig. 1). The catch in those postwar seasons consists mainly of sei and sperm whales, and the former species amounts to more than 50% of the catch in very season. Since the 1950 season this species have been accounting for even more than 80% of the catch, because of the change of operating season due to the amendment of the International Whaling Regulations and the favorable price of this whale. In recent years, the relative importance of the whaling in the Bonin waters to the Japanese coastal whaling have increased, partly because the productivity of the former operation has been augmented by the adoption of the floating factory system and the efficient catcher boats, and partly because the productive whaling grounds in the Kuril and Korean waters was lost because of the war (Table 1).

In keeping with the increasing importance of the sei whale of the Bonin waters as the fishery resource, the biology of this whale is investigated actively. With the progress of the study, it has become more probable that this whale is not the true sei whale, *Baraenoptera borealis*, but the Bryde whale or it very close relative.

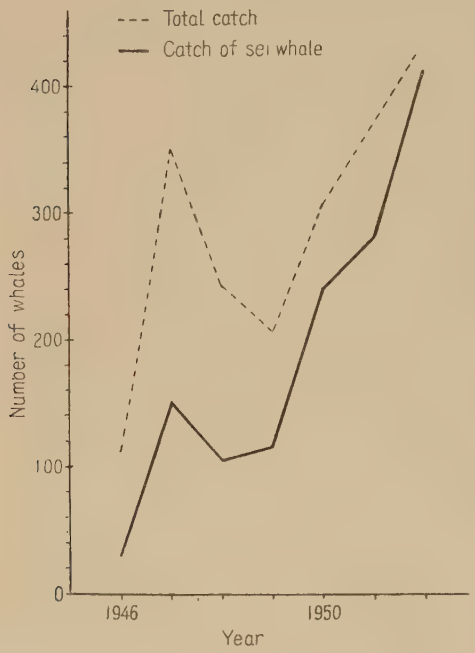

Fig. 1. Number of Catch by year

Table 1. Whale Catch by the Japanese Coastal Whaling and its Part Taken in the Bonin Waters

Season	Japanese Coastal Whaling (Number)	Bonin Waters	
		(Number)	(Percentage)
1937	2050	160	8.2
1951	2300	340	14.8

Several authors have hitherto investigated in the sexual maturity of the sei whales of the adjacent waters of Japan. Andrews (1916) reported a pregnant female of 25 ft. in length. This individual, however, should be regarded as an exceptional case, if it was not a mink, but really a sei whale. Hayashi (1927) concluded, on the basis of his anatomical study of the ovary, that the female attain sexual maturity at lengths greater than 12 m. (40 ft.). According to Matsuura (1935), however, the length of the female at sexual maturity is not more than 40 ft., because pregnant females range between 40 and 43 ft. in length. Kasahara (1950) studied the sexual maturity of the male as well as of the female, and also distinguished the individuals caught in the Bonin waters from those caught off the pacific coasts of Sanriku (northern Honshu) and Hokkaido. Based on the graph in which the length of the male is plotted against the weight of the testes and on the presence or absence of corpus luteum, he approximately estimated the lengths of the two sexes at sexual maturity as follows (male : female): 41 ft.: 41 ft. for the Bonin group and 43–44 ft. for the Sanriku-Hokkaido group. He ascribed this regional difference in the length at sexual maturity to the fact that the whaling is operated in the Bonin waters about a half year earlier than in the Japanese coastal waters, and con-

sidered that the whales grow by that length while they are migrating from the former region to the latter. Along the same line of reasoning, he estimated the growth rate of the sei whale at 2–3 ft. in 5–6 months.

Omura (1950) determined the length of both sexes at sexual maturity for the three different whaling grounds, namely Bonin Islands, Sanriku (Ayukawa to Kamaishi) and Hokkaido (Kushiro to Kiritappu). His result follows:

	Bonin Islands	Sanriku	Hakkaido
Male	40 ft.	42 ft.	43 ft.
Female	41 ft.	44 ft.	45 ft.

On the basis of the herein indicated geographic differences in the length at sexual maturity, he presumed that the sei whales of the Hokkaido waters and those of the Bonin Islands waters belong to different populations, and that the two populations mix in the Sanriku waters. In his study, females with any corpus luteum and males with a testis weighing 1.0 kg. or more are regarded as sexually mature.

Since Omura published this study, a group of Japanese biologists have collected, under his leadership, the various evidences which support his theory and distinguished the sei whales in the adjacent waters of Japan into the northern and southern types. The northern type is considered as preponderant in the Hokkaido waters, and the southern type, in the Bonin waters. The most notable characteristic distinguishing the two types are the colour and structure of the baleen plates.

Chapter I. Material and Methods

The material for this study consists of the 694 sei whales taken in the whaling area round the Bonin Islands in the 1951 and 1952 seasons by the whaling fleet of the Kyokuyo Whaling Co., Ltd. accompanied by the floating factory Baikal Maru. The operating period was May 1—June 10, 1951 in the former season, and May 1—June 20, 1952 in the latter. In the two seasons the whaling fleet operated in the nearly same area (Fig. 2). The sex composition and average lengths of different sexes of these whales are shown in Table 2. Length frequency distribution of these whales is illustrated in Fig. 3.

That all these whales belong to the aforementioned "southern type" has been ascertained from the characteristics of the baleen plates. Sample baleen plates were collected from all individuals and are preserved.

Of course, it is nearly impossible to sample a whale stock according

to a well-defined plan. In order to compensate for this disadvantage, the sample size, i. e. the number of the whales to be examined, as large as possible is desired. From this standpoint, the catches of the two seasons are combined and subjected to analysis, because they consisted exclusively of the southern type, and were taken in the nearly same area and in the nearly same season of the year during a relatively short period of time, (i. e. one and a half months). The difference in the length composition between the catches of the two seasons has also been taken into account.

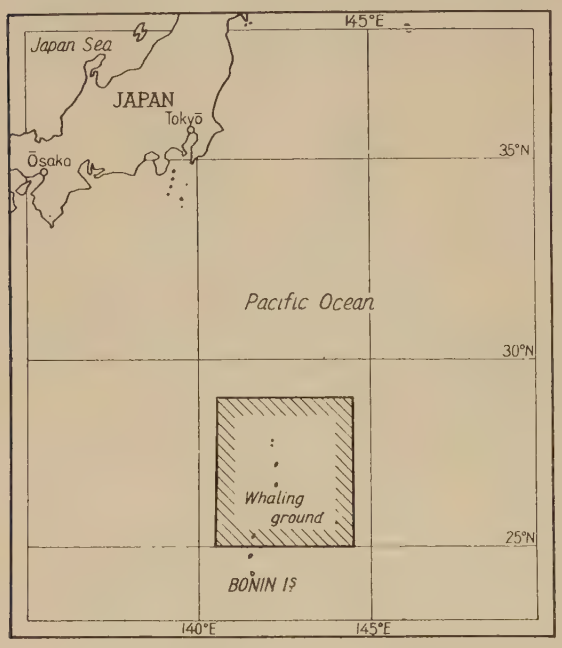

Fig. 2. Whaling Ground of Bonin Area

Sexual maturity of the male is determined by the histological method. Immediately after the carcass of a male is dismembered, a sample piece of about 1 cm. cube is taken from the gland tissue about 1 cm. underneath the free surface of the central part of each testis, and fixed in the alcohol-formalin solution (1 part of 10% formalin solution in 9 parts of 60% alcohol). At the same, each testis is weighed. In the laboratory, the sample piece is sectioned,

Table 2. Sex Composition and Mean Length of the Sei Whales used as the Material

Season Caught	Male			Female			Sex Ratio
	Number	Length (ft.)		Number	Length (ft.)		Male : Female
		Mean	Standard Deviation		Mean	Standard Deviation	
1951	157	41.7	1.56	126 (1)	42.3	1.39	57.6 : 42.1
1952	270 (3)	41.7	1.25	141 (7)	42.5	1.52	65.7 : 34.3
Total	427 (3)	41.7	1.56	267 (8)	42.4	1.41	61.7 : 38.3

double-stained by haematoxylin and eosin and examined under the microscope for the presence of spermatozoa. If completely metamorphosed spermatozoa is found in the sample piece, the testis, hence the whale, from which the sample piece is taken is regarded as mature.

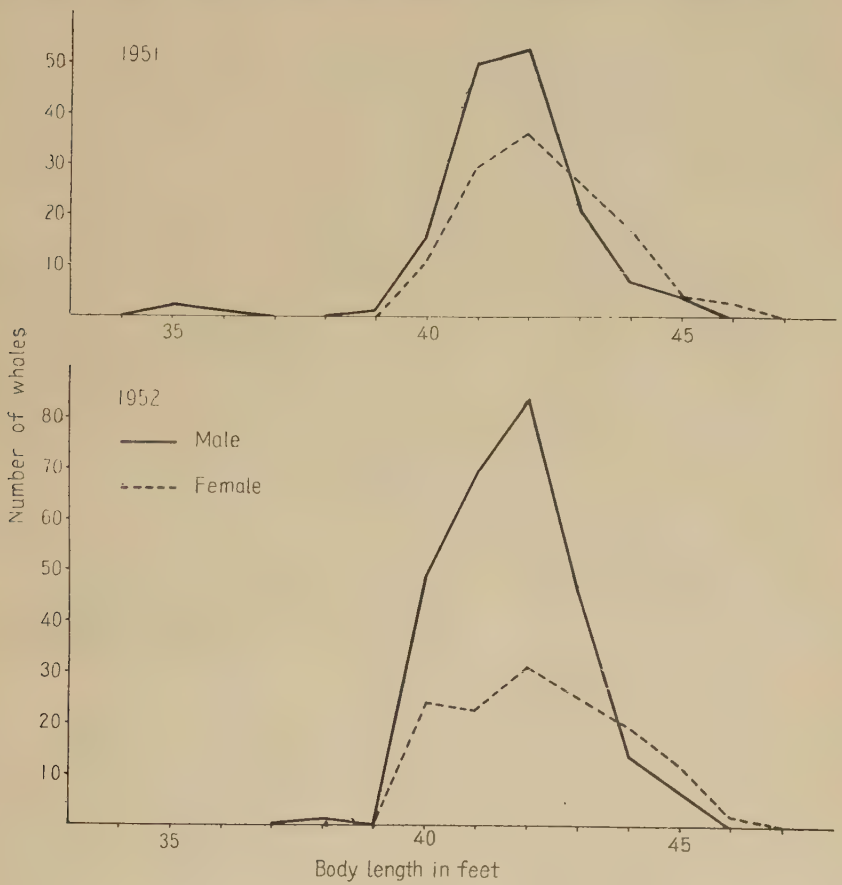

Fig. 3. Frequency Curve of Body Length.

It may happen that the testis which is determined as immature by this method is actually mature, containing metamorphosed spermatozoa in its other part than the sample piece. This possibility limits, to some extent, the applicability of the result of the determination. For practical purposes, however, the result of this method can be applied with little, if any disadvantage, because neither the length of the whale at sexual maturity nor the weight of the testis at its maturity can be estimated smaller than the truth.

In the female, sexual maturity is determined on the basis of the female, sexual maturity is determined on the basis of the corpus luteum evidence.

In the female, sexual maturity is determined on the basis of the corpus luteum evidence.

The collection of the material, i.e. weighing the testis, taking and fixing the testis sample, and examining the ovaries for the presence of corpus luteum, is carried out by the government inspectors and the biologists on board the floating factory.

Chapter II. Sexual Maturity of the Male

Based on the results of the examination of all the testis samples, the percentage maturity of the testes is calculated for each testis weight class, and graphed in Fig. 4.

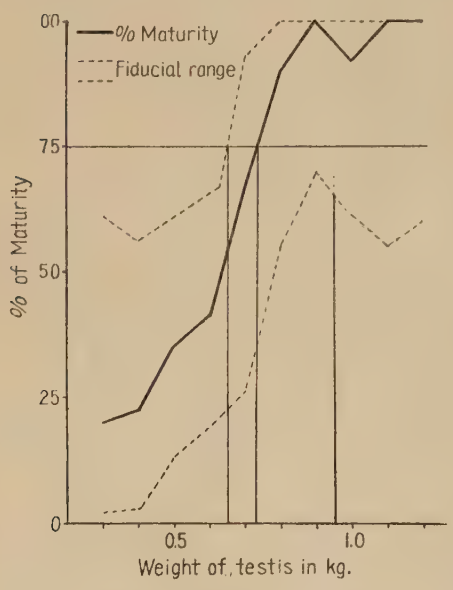

Fig. 4. Maturity of Testis.

In the graph, the testis weight corresponding to the percentage maturity of 75% is 0.74 kg, its fiducial range being 0.63–0.95 kg. at the significance level of 5%. Hence, statistically the testis of the sei whale of the "southern type" becomes mature at the weight between 0.63 and 0.95 kg, and in average at 0.74 kg.

In Fig. 5 the weight of the testis is plotted against the length of the whale, and discrimination is made between mature and immature testes. The general trend suggested by the graph, though not very distinct because the dots are not sufficiently many, is that the relative frequency of the mature testes is more closely correlated to the weight of testis than to the length of the whale. And the relatively extensive scattering of dots in the direction of the length of the whale probably represents the considerable variation of the length within each age-class.

In Table 3 the male whales are classified in respect to the relative weights of their right and left testes. The statistical analysis of the

result shown in Table 3 indicates that there is no such tendency that heavier testis occurs on the definite side of the body. This fact suggests that there is little sense in segregating the right testis from the left for the purpose of making comparison between right or left testis only, and that the combined weight of the right and left testes is a more suitable measure for comparison than the weight of the testis of one definite side.

In Fig. 6, the combined weight of the pair of testes is plotted against the length of the whale. Only a few whales are smaller than 40 ft., because this is the minimum length limit provided by the regulations. In Fig. 6, in contrast with the similar graphs for other whales, it is difficult to define such a whale length above which sexually mature individuals predominate and below which immature whales are dominant. (This fact may be interpreted to indicate that the present length limit is stringent enough to protect the immature male.) Although the weight of the testis is positively correlated to the length of the whale, the relationship between the two factors is much obscured by the considerable dispersion of the dots, particularly in the lower length classes.

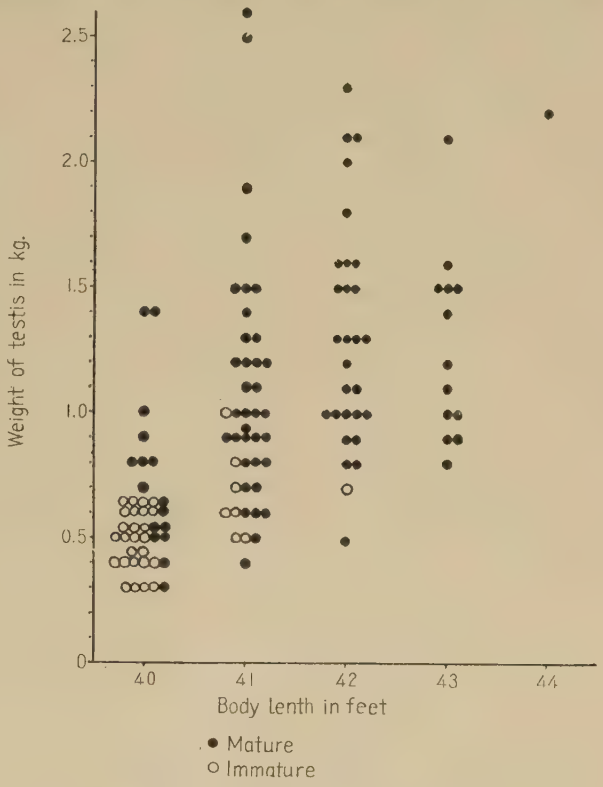

Fig. 5. Weight of Testis and Body Length, stained as the Maturity of Testis.

Table 3. Number of the Male as Classified According to the Relative Weights of the Right and the Left Testis.

Season Caught	Left Testis Heavier	Both Testes Equal in Weight	Right Testis Heavier
1951	44	31	82
1952	93	116	58
Total	137	147	140

Therefore, it may well be said that the length at which the male sei whales of the Bonin waters attain sexual maturity can hardly be estimated correctly by the simple observation of the graph in which the weight of the testes is plotted against the length of the whale.

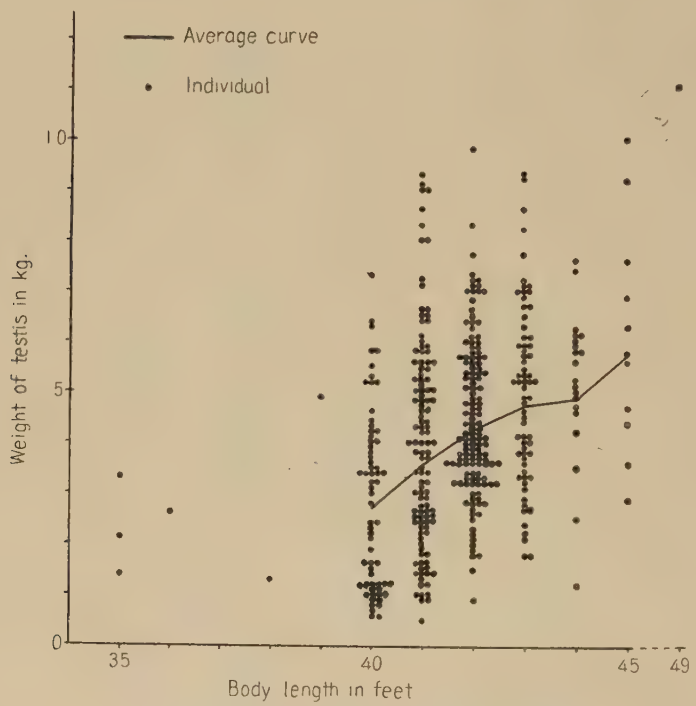

Fig. 6. Weight of Testes and Body Length.

With the view of overcoming these limitations of Fig. 6, the percentage maturity is calculated for each length class, and used for the determination of the length at sexual maturity. Since it has been statistically shown that a testis weighs an average of 0.74 kg. at its maturity, a whale is regarded as sexually mature if its pair of testes weighs more than twice as much, i.e. 1.5 kg or more. The result is illustrated in Fig. 7.

Statistical computation shows that the length of the whale corresponding to the 75% maturity in Fig. 7 is 40.4 ft. and its fiducial range is 39.8–40.9 ft. at the level of significance of 5%.

To sum up, the length of the male sei whale of the Bonin waters at sexual maturity is estimated at 40.4 ft. on the basis of the measurements taken in May and June.

Of the males examined in this study, i. e. those taken in the 1951 and 1952 seasons, about 90% were sexually mature. Accordingly, one may consider that the majority of the male sei whales taken in the Bonin waters are mature, as far as the present regulations are operative.

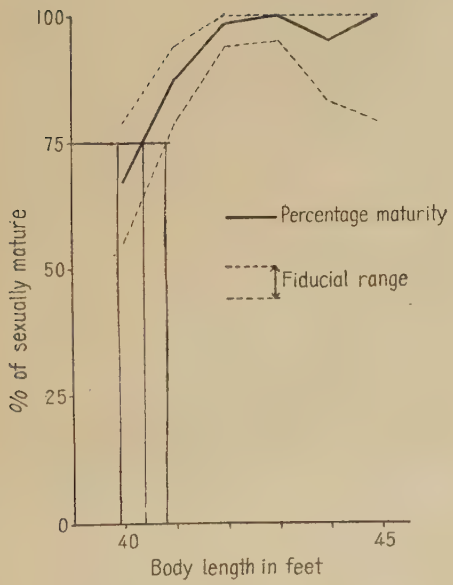

Fig. 7. Sexual Maturity of Male

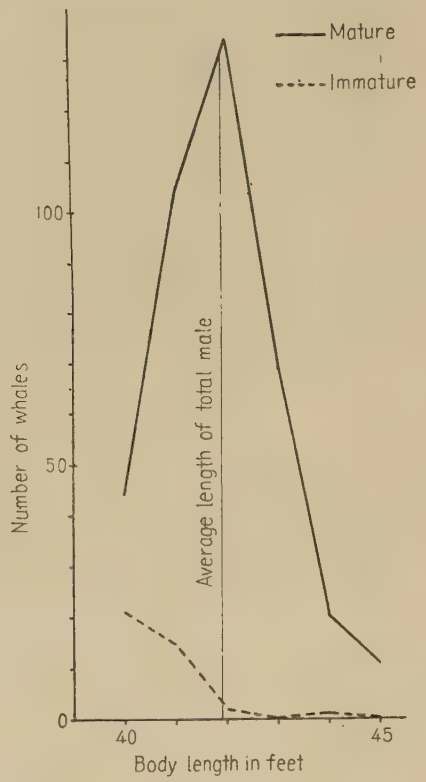

Fig. 8. Frequency Curve of Mature and Immature Male

Fig. 8 shows the length composition of the sexually mature and immature groups of the males taken in the 1951 and 1952 seasons. The modal and the mean length of the mature group are 42 and 41.9 ft., respectively.

Chapter III. Sexual Maturity of the Female.

Fig. 9 shows the relation between the length of the female and the number of the corpora lutea in its both ovaries.

A female is regarded as sexually mature if any corpus luteum is found in its ovaries. And the percentage of the sexually mature in-

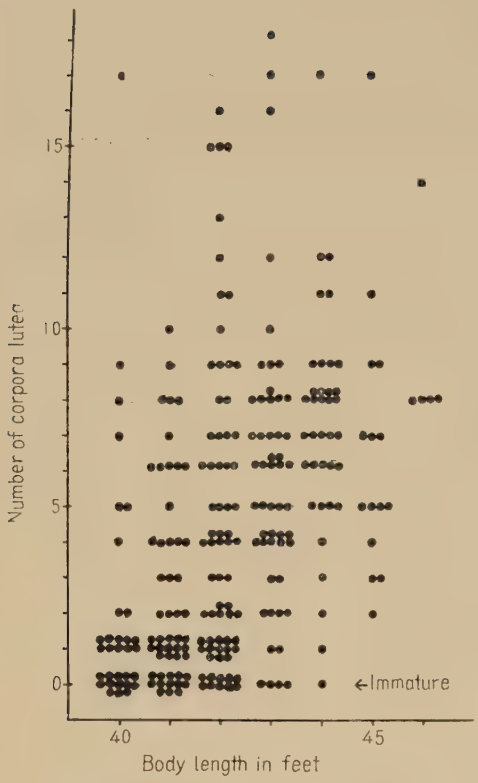

Fig. 9. Number of Corpora Lutea and Body Length

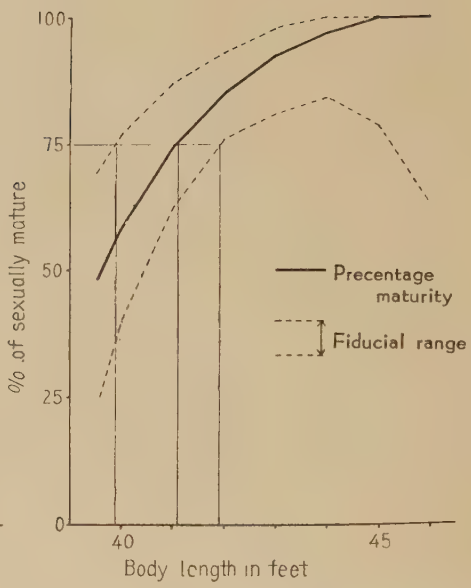

Fig. 10. Sexual Maturity of Female

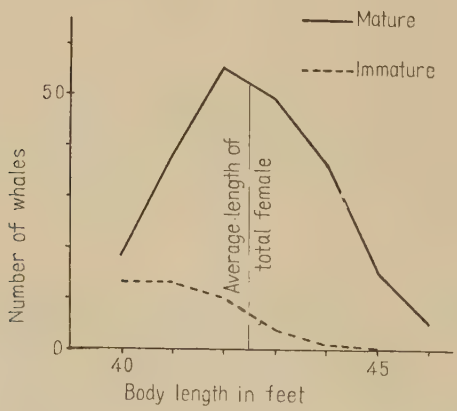

Fig. 11. Frequency Curve of Mature and Immature Female

dividuals, or the percentage maturity, is calculated for each length class of the female. The result is illustrated in Fig. 10.

By the statistical method, the length corresponding to the 75% maturity in Fig. 10 is estimated at 41.1 ft., and within the fiducial range of 39.9–41.9 ft. at the 5% level of significance. This fiducial range is wider than was estimated for the male in the preceding chapter, probably because fewer females are examined than males. (259 females are examined as against 424 males.)

Of the females taken in the 1951 and 1952 seasons, 84% were sexually mature. This percentage maturity is lower than that of the males taken in the same seasons.

Fig. 11 shows the length composition of the sexually mature and immature groups of the females taken in the 1951 and 1952 seasons. The modal and the mean length of the mature group are 42.0 and 42.5 ft., respectively.

Discussion and Conclusions

Since the appropriateness of determining the sexual maturity of the female whale on the basis of the corpora lutea evidence is almost established, it may be said that maturity or immaturity of each individual female has been determined with great certainty in this study. In estimating the length of this sex at sexual maturity, a much large sample has been used than in the preceding studies. (Omura's (1950) sample was the largest in the past, containing 93 females, while our sample consists of 259.) Nevertheless, the fiducial range of the estimate has been considerably wide. These facts seem to suggest that a still larger sample is necessary for a narrower fiducial range.

The determination of sexual maturity of the male is much more difficult than in the female. The most reliable method over derived for this determination is probably such histological one as was used in this study. If well developed spermatozoa are detected in the histological sample of a testis little problem occurs in interpreting the result. If spermatozoa are not detected in the sample piece, two interpretations are possible: (1) the testis is immature and (2) the testis is mature, and contains well developed spermatozoa in some other part of it than the sample piece. The latter possibility can not be denied entirely, although the maturity of the various parts of a testis was compared in the preliminary study and the histological sample for the present study was taken from one of those parts where maturity is attained

earliest. As a counter-measure, the juice squeezed from the testis was smeared on the slide glass and examined microscopically. But this method did not prove to be effective. Consequently, we have decided to regard a testis as immature if completely metamorphosed spermatozoa was not found in its histological sample, and to content ourselves with the fact that the percentage maturity computed according to this criterion increases sharply above certain length of the whale or weight of the testies.

Regarding the accuracy of the estimated lengths of the whale at sexual maturity, following two points should be mentioned. Firstly, these estimates are based on the whales taken by the commercial whaling operations, and these whales are not warranted to be a representative sample of that stock of the whale of which we wish to know. Secondly the length of the whale is not measured very accurately.* The accuracy of the aforementioned estimated length is limited, in either sex, by these factors, however carefully the data may be analyzed.

In this study, the weight of the pair of testes of 1.5 kg. has been used as a criterion to distinguish sexually mature and immature males. If 1.2, 1.4, 1.6, 1.8 or 2.0 kg. is used as the criterion instead of 1.5 kg. and the same process of computation is followed as in Chapter II, the length of the male at sexual maturity is estimated respectively at 40.2, 40.3, 40.5, 40.6 or 40.7 ft., or with in the fiducial range that was computed with 1.5 kg. as the criterion. This fact may be interpreted to suggest that the weight of the testes of 1.5 kg. is an appropriate criterion. In the light of the results of the present study, e.g. the result of the histological examination and the estimated length at sexual maturity, the weight of the testis of 1.0 kg. seems to large as a criterion for distinguishing mature and immature males. And it is our opinion that, while the weight of the single testis is a good index of the maturity of the testis, the weight of the both testes is superior to the former as an index of the sexual maturity of an individual, and that the double of the weight of a single testis at its maturity is to be used as the criterion for distinguishing the sexually mature and immature males.

The results obtained in this study are summarized as follows.

1. The sexual maturity of the sei whale of the so-called "southern

* This does not mean that whalers make false statements, for their convenience, of the length of the whales they have caught. The measurement of the length of the whale become "inaccurate", because it is difficult to take the measurement strictly in compliance with the definition ("on the level in a straight line"), because the whale on the dismembering deck is seldom straightened and seldom in the position that is normal when it is alive in the sea, and because the reading under 1 ft. is rounded up.

type" is studied with the material secured in the Bonin whaling ground in May and June.

2. On the basis of histological examinations, the weight of a single testis at it maturity is estimated at 0.74 kg., its fiducial range being 0.63–0.95 kg. at the 5% level of significance. A male is regarded as sexually mature, if its both testes, in combination, weigh more than 1.5 kg. (the double of 0.74 kg.) The length of the male at sexual maturity, which is defided as the length corresponding to the percentage maturity of 75%, is statistically estimated at 40 ft. and within the fiducial range of 39.8–40.9 ft. at the 5% level of significance.

3. Whether a female is sexually mature or immature is determined from the presence or absence of a corpus luteum in its ovaries. The length of the female at sexual maturity, which is defined in the same manner as that of the male, is estimated at 41 ft. and within the fiducial range of 39.5–41.9 ft. at the 5% level of significance.

4. The present regulations forbid the floating factory whaling catcher to take sei whales under 40 ft. long in the Bonin waters. This size limit is considered to be more stringent and protecting the whale stock more effectively, if not perfectly, than any other size limit now applied to various species of whales.

In conclusion, we wish to express our sincere gratitude to the crew of the Baikal Maru fleet of the Kyokuyo Whaling Co., Ltd. for supplying the material for this study, and to Messrs. S. Nishimoto and K. Ozaki, government inspectors, and Messrs. T. Kawakami and K. Fujino, biologists, for collecting the material in the field.

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Studies of the Relation between the Whaling Grounds and the Hydrographical Conditions (I).

By

Michitaka Uda

Introduction

By the request of the Whaling Vessel-equipments Improving Committee and by the courtesy of the Whaling Companies in Japan (Taiyō, Nippon Suisan, Kyokuyō, Nittō, Kinkai Hogei Fisheries Co.) together with Whales Research Institute, the data of the whaling grounds in the waters adjacent to Japan during 1910–1951, the daily whaling reports of all catcher boats and the monthly whaling reports were given to the author at his disposal in order to study them. He plotted the maps of yearly whaling grounds for each ten days and of the annual fisheries grounds.[1)2)3)]

In the opportunity the author wishes to state his sincere thanks to the fishing companies above mentioned and the director of the Whales Research Institute Dr. Tsutomu Maruyama and the director Dr. Hideo Ōmura for their encouragement, and also to all captains of the catcher boats who have prepared the correct data by their zealously continued observations. Also he wishes to state his heartiful thanks to the aids and cares given during his researches by the Whaling Vessel-equipment Improving Committee (President Mr. Iwao Fujita and its Charge in Press, Mr. Takao Ban and the Chief of Research Section in the Fisheries Agency, Dr H. Ōmura.

Basing on the 10 days reports of whaling grounds, the charts prepared by us have shown clearly the location of fishing-grounds for each species of whales, the date of catch, the abundance of catch, its body length, stomach-contents, the data of whales seen, isotherms and currents with the general description of the sea conditions. The annual report of whaling ground charts have shown the iso-lines of the catch of sperm-whales, sei-whales and fin-whales on the basis of the summarized number for each rectangle of 1 degree of longitude and latitude and as its consequence the location of the most concentrated abundance of whales. Also the amount of catch for each sea-districts for each decade and the body-length were shown in additional tables.

Hitherto, with respect to the whaling fishing grounds there appeared the researches carried out by Mr. Yoshio Matsuura[4)], H. Ōmura[5)6)]

K. Kasahara,[7] K. Midunoe,[8] K. Otsuru,[9] the Japan Whaling Association[10], the Central Meteorological Observatory,[11] the Tōkai Regional Fisheries Research Laboratory[12] and Mr. Z. Nakai,[13] however there lacks the detailed study of the relation between the yearly whaling grounds and the hydrographical conditions.

Basing on the above charts (for annual and each decade), the whaling grounds in the waters adjacent to Japan; the Northern Kurile, the Middle Kurile, the Southern Kurile, the Northern Coast of Hokkaidō (off Akkeshi, Kushiro), the North-eastern Sea-region of Japan (off Sanriku, off Kinkazan and off Fukushima and Ibaragi Prefectures), off Kishū (Kumano-nada), Ogasawara, Kyūshū (SE-sea region, Gotō-nada, Tsushima Strait), South Western Islands (Amami Ōshima and Ryūkyū etc.), the South Sea to Formosa, the Yellow Sea, off the Southern Korea, the Eastern Korea, the Japan Proper-side faced to the Japan Sea.

We can inspect the yearly variation of those whaling grounds easily, and refering to the oceanographical charts we can at once point out the following features:

1. *The General Trends of the Whaling Grounds.*

(1) During 1910–1926 (Meiji, Taishō eras) the whaling grounds were remarkably coastal one in general and among them the conspicuous whaling grounds off Kinkazan, Sanriku and Kii were also limited in the very coastal area by the capacities of the whaling navigation and the whale processing at that time.

(2) The whaling grounds in the period after the year 1926 extended its circle to the offing of Kinkazan and especially developed in South Kurile region and the regions north and south off Hokkaidō.

(3) Entering in Syōwa era, during the years from 1932 to 1941 the whaling grounds have been extended to the North Kurile region and marked with its prosperous fishing. Also in that period the Ogasawara Whaling grounds and the grounds adjacent to Korea developed remarkably.

(4) After the last World War II, we have lost the whaling grounds in the waters adjacent to Kurile and in the Yellow Sea, but we can now continuing the fishing in the grounds mainly from the offing of Kinkazan to the offing of Akkeshi (Hokkaidō), partly off the north coast of Abashiri (Hokkaidō), Ogasawara and Kii (Shiono-misaki).

2. *Relation between the Variation of Whaling Grounds in Each Year and the Corresponding Hydrographical Fluctuation.*

(1) In the years of the prosperous cold current such as 1934 the

whaling grounds distribute relatively to the south with its center of grounds and extend conspicuously to the east offing. The catches in the central and southern districts of the North-eastern Sea-district of Japan are more abundant than that in the Hokkaidō ground.

(2) In the cold years two centres of the whaling grounds, the offing one and the coastal one, can be observed. Those correspond to the two frontal regions of warm and cold currents at their heads of the coastal and offshore cold current respectively. The ratio of the areas of fishing grounds varies in correspondence to the relative fluctuation of the two cold currents above mentioned.

(3) In the year 1948 the state of the sea was normal, showing remarkably rich catch on the whaling ground off Kinkazan. During the years from 1944 to 1949 in accompany with the gradual decay of the cold current tending to warmer, the whaling ground extended its circle to north than before and accordingly translated its centre of gravity to north in the fishing ground off Akkeshi (Hokkaidō).

In short, in the former period of years during 1933–1941 (the prosperous period of warm current), the prosperity of the northern fishing ground off Kurile Islands was shown. After then corresponding to the decay of warm current and the development of cold current the whaling ground temporarily tended to translate to south than before. However after the elapse of ten years in accompany with the rise of warm current again the grounds have shown the tendeny to come back to the north.

(4) The fishing grounds of sei-whale show somewhat later appearance seasonally in the northern district than those of sperm-whale relatively in southern (warmer) region, more approaching to the coast compared to those of sperm-whale.

(5) We are now in the course of researches on the optimum temperature for each species of whales. However, roughly speaking, the range of the water temperature at the time of catch is prettily broad and lies in the range 5°–28°C, centering at about 12°–23°C. Probably the optimum temperature may be separated in two parts of 12°–16°C and 17°–23°C as those due to the optimum temperature of the feeders or due to the two fronts (Oyashio- and Kuroshio-Fronts).

3. The Oceanographic Structure Determining the Whaling Grounds are as in the following.

(1) Each boundaries of water-masses (fronts) determine the favourable fishing grounds. Or in other words, they have intimate relations to the distributions of the vertical and the horizontal gradients of water temperature. Particularly the massive centre of the whaling

grounds locates in the zone where the cold and warm current collide each other (i.e. where the cold current creeps beneath the warm current, accordingly the vertical gradient of water temperature shows its maximum of the super-saturation of dissolved oxygen).

(2) The boundaries between the cold upwelling water-mass of a cyclonic eddy and the warm water-mass, forming a cyclonic revolving pattern of the tongues of cold and warm currents corresponds to the centres of the most favourable whaling grounds. (Fig. 1, 2.) It may

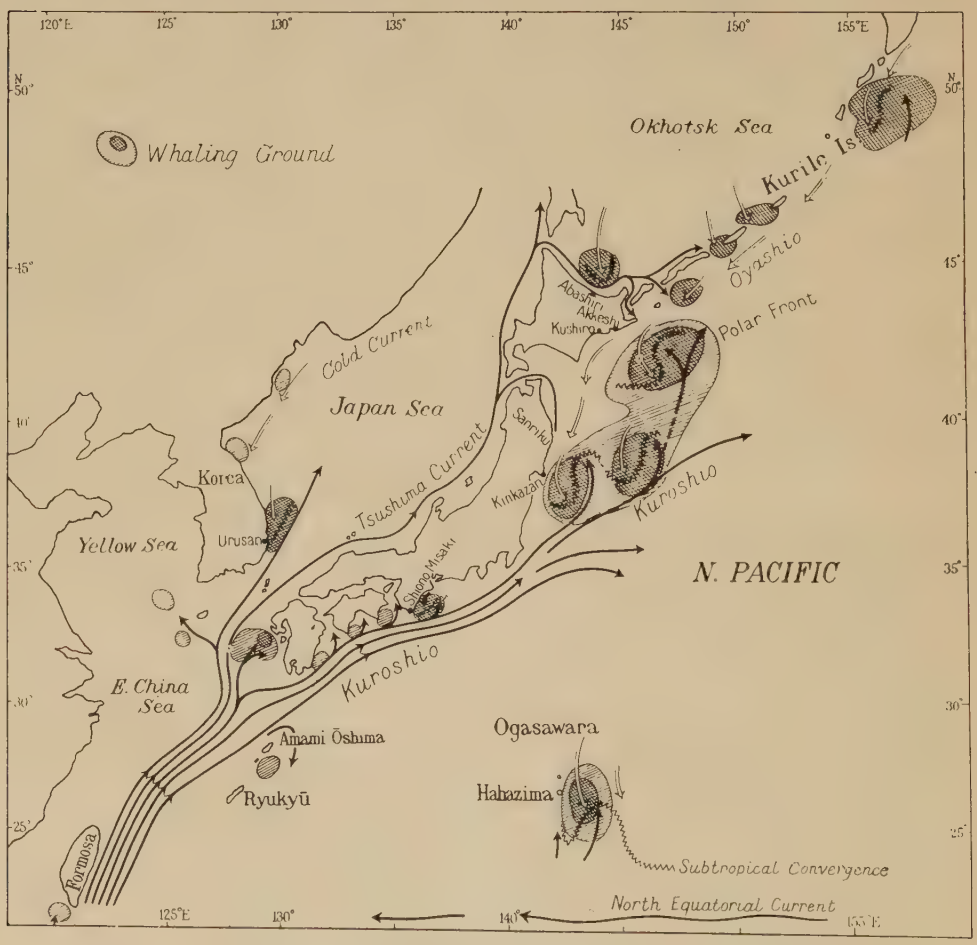

Fig. 1. Distribution of whaling grounds in relation to the boundaries of water masses (fronts) and currents.

be due to the rich zone of the foods of whales involving, euphausid, copepods, squids and sardine, anchovy etc. which were assembled to

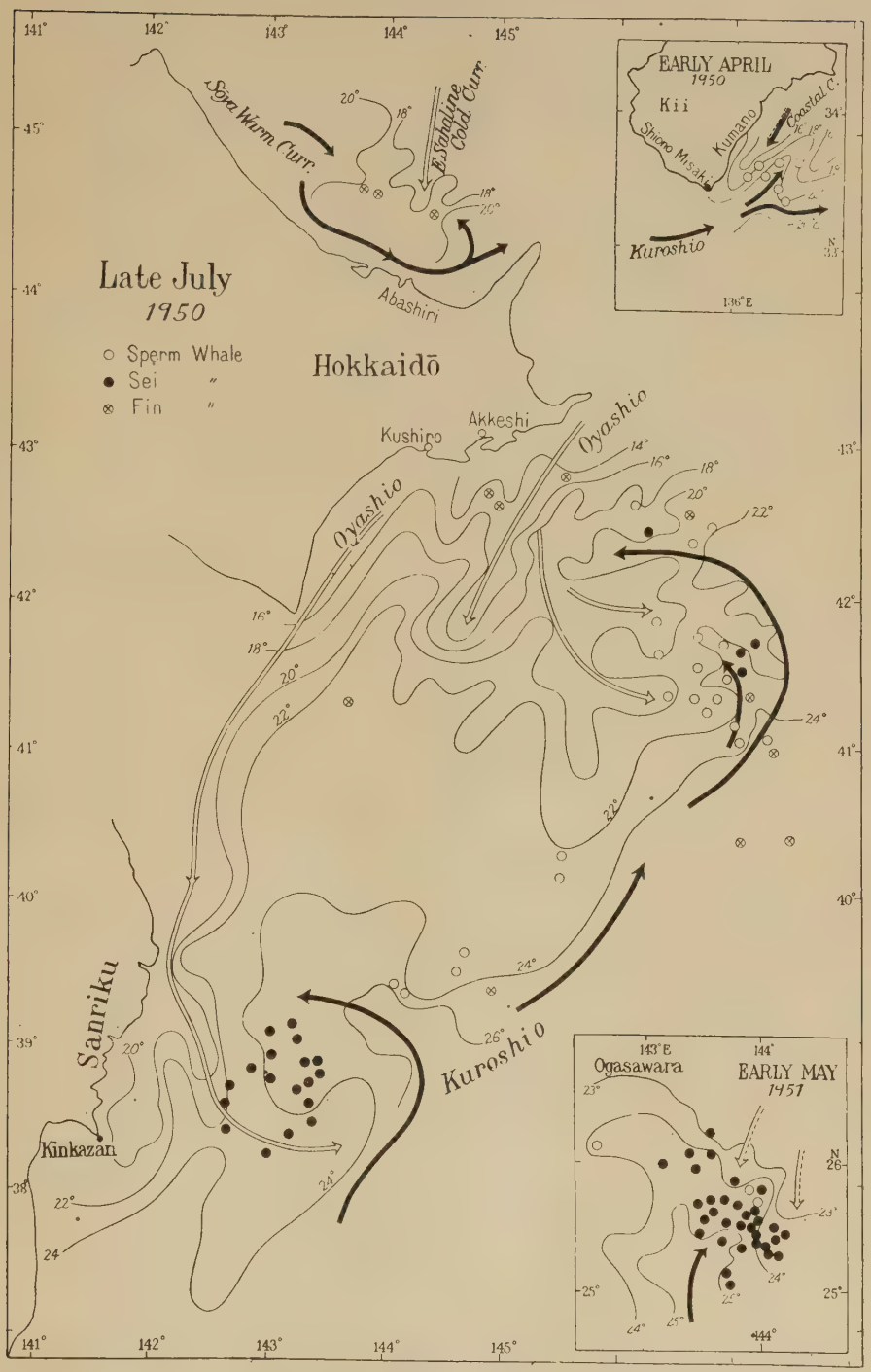

Fig. 2. Typical examples of the distribution of the whaling grounds, surface water temperature and currents.

the boundary of water masses by the convergence of currents.

(3) The migrating route of whales appears in the zone of abundant food. It seems that the migration of whale schools and accordingly the movement of their central whaling grounds are subjected by the north and south movement of the front of abundant food zone. One migration route along the band of comparatively cold water on the Japan Trench stretching in the longitudinal direction to the east side of the ridge of Fuji volcanic mountains, from Ogasawara fishing ground to the Southern NE-Sea district of Japan, was inferred by the recaptured report (sei-whale) of the whale marking experiment,[14] and another route from the east off Ryūkyū and Amami Oshima, off Tosa, Kii Kumano-nada to the south part of NE-Sea district of Japan were also inferred. After jointing together the above two systems of whale schools going to north migrate from the offing of Kinkazan to the offing of Akkeshi and further to the Kurile sea-region.

(4) The mixing of the several species (sperm-whale, sei-whale, humpback-whale, blue-whale and in the north fin-whale) can be seen most remarkably in the fishing ground off Kinkazan, and the next in the ground off Akkeshi, also in the ground east off Ogasawara (Bonin Is.)

(5) Generally the whale school does not concentrate densely in the easterly rapid flowing zone of warm current and not long there it passes through the zone rapidly. Accordingly the whaling grounds are poorly found in the westerly drift wind current area (a branch of Kuroshio) in the North Pacific Ocean and Kuroshio itself.

(6) The details of the whaling grounds in relation to the water boundaries (fronts) are as follows.

(a) The Ogasawara fishing ground lying east to the Ogasawara Hahazima where it corresponds to the region north of the line of Subtropical Convergence nearly crossing the Japan Trench, indicates a highly productive zone and especially in the seasons of winter and spring (from Dec. Jan. to May having its centre in spring) it exhibits one of the most favourable whaling fisheries (sperm-, humpback and bluefin-whales mixed zone). Here, the cyclonic rolling eddies locating in the cores of waters boundary formed by the north-going warm branch of the North Equatorial Current and the cold water influenced by the upwelled south-coming Oyashio Under-current (intermediate water). The subtropical Convergence indicates nearly the southern limit of the whaling ground and of albacore fisheries ground.

(b) The whaling grounds off Kinkazan correspond to the cores of the water boundary between the Oyashio Cold Current and the northern

branch of the Kuroshio Warm Current, forming the cyclonic rolling eddies in the zone limited by the Oyashio Front (Polar Front) and the Kuroshio Front (the northern marginal line of the Kuroshio main current). The fishing season extends over the whole year, but its prosperous period lying in May—Nov. (spring, summer, autumn) of this well-known great whaling grounds of the longest season corresponds to the long stay of whales (sperm-, sei-, fin-, blue- and humpback-whales mingled).

(c) The whaling grounds off Akkeshi and Kushiro (in the southern sea off Hokkaidō correspond to the cores of water-boundary forming cyclonic eddies in summer and autumn by the Oyashio Cold Current flowing to southwest along the south coast of Hokkaidō and the north-going warm branch of Kuroshio Current (NE warm branch current). In its fishing season from May to Dec. (prosperous in summer and autumn) the whale shoals (mainly sperm-, sei-, fin-whale and sometimes bluefin-whale mingling in them) are observed.

(d) The whaling grounds in the waters adjacent to Kurile Islands appears in summer in the frontal zone of cold watermasses of Oyashio flowing out from the Okhotsk Sea through the Straits of Kurile in warmer watermass of the North Pacific Ocean.

In particular the Northern Kurile whaling ground is formed in the water boundary between the north-going warm branch current towards Kamtchatska Penninsula and the North Kurile sea-region. It is noted as whaling ground (mainly of sperm-whale) in the season from June to late August. The middle Kurile whaling ground located in the area between Shinshiru and Uruppu Islands, showing the whales (mainly sperm-whale mixed with sei- and fin-whales) in the fishing season from middle May to middle Sept. The Southern Kurile whaling ground lies off the Etorofu Is. and Shikotan Is. in the season from May to late Sept, showing mainly sei-whale mixed with sperm- and fin-whales. The Southern Aleutian whaling grounds (sperm- and fin-whales) appears in the water boundary formed between the warm branch current flowing strongly towards north during June and July and the cold current in the Northwestern part in the Bering Sea.

(e) The whaling grounds (mainly of fin-whale) north off Kitami (Abashiri) of Hokkaidō are formed in the cyclonic eddies by the front between the south-coming East Saghaline Cold Current and the coastal Sōya Warm Current strengthened by the geomorphological conditions of the Okhotsk Yamato Bank and Cape Shiretoko. The fishing season begins in late June, prosperous in July (the maximum) and ends in early Sept.

(f) The whaling grounds in Kumano-nada are narrow and near the

coast, forming cyclonic eddy located at the water boundary (front) between Kuroshio Main Current and the Coastal Cold Current in the fishing season from January to July (in April, May, sperm-whale and in June, July sei-whale dominantly).

(g) In some years the humpback-whaling ground was observed in the waters to Okinawa coast during January—April.

(h) The humpback-whaling ground off Goarampii south of Formosa was seen in the winter (Jan.-March).

(i) In the whaling grounds west to Kyūshū, fin-whale (Jan.—April), sei-whale and sperm-whale (May—Nov.) and again fin-whale (June—Dec.) were caught. The fishing grounds are divided in three parts (Gotō Is., Yobuko-Iki Is. and adjacent to Koshiki-zima).

(j) The fin-whale ground in the Yellow Sea have the fishing seasons during Jan.—April (May) and in Oct.—Dec.

(k) The Urusan whaling grounds of fin-whale were seen in the fishing season during August—November.

(l) The fin-whale whaling grounds off Genzan and Seishin along the east coast of Korea were seen during March—April, Dec.—Nov.

(m) The fin-whale grounds in March and April in the waters adacent to Sado and Noto were also observed in past years.

7 Remarks on the Antarctic Whaling Grounds.

There are greatest whaling grounds in the world located around the water-boundaries circumscribing near the Antarctic Continent, which correspond to the most abundant area of the food of whales (euphausia) and they can be found by the oceanographic surveys or aerial surveys by helicopter. The principles of the formation of whaling grounds may be the same throughout the waters adjacent to Japan in the North Pacific and in the Antarctic Ocean.

Concluding Remarks.

Now we can foretell the variation and location of whaling grounds by investgating the oceanographic conditions and whaling conditions continuously year by year as stated in above and by availing the maps of whaling grounds, and also we can supply some important data to the scientific control of the whaling.

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Postscript.

(1) We can distinguish the following 4 types of the whaling grounds in the above charts;
the warm front type at the head of the north-going warm current (Apr.—Aug.), the cold front type at the head of the south-going cold current (Sept.—Dec.), the stationary front type (summer, winter) and the occluded front type (most favourable fishing grounds, however not persistent, feasible to change and disappear).
(2) The central localities of the main whaling grounds in the NE-sea district are at about (40°–43°N., 144°–147°E.) off Akkeshi, (37°–39°N., 142°–144°E.) and (38°–48° N., 144°–146°E.) off Kinkazan.

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